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War Gas Used to Kill Silk Cocoons. A war gas made by Prof. Gabriel Bertrand of the Pasteur Institute has found a peace-time use in the silk industry. The silk cocoons are gassed by small quantities of chloropicrin which has proved exceedingly practical and easy to handle.

The gas has been tried out in various silk-raising centers and has been found to possess marked advantages over killing the cocoons by baking or steaming. Under the prevalent methods of silk culture the cocoons have to be all sold within a period of two or three weeks, but the use of chloropicrin promises a practical way, it is said, for the growers to turn the cocoons into non-perishable merchandise which can be sold when the market is best.—*Science Service*

Vitamin Feeding Makes Better Chickens. Hens given vitamin A in addition to their regular diet not only hatch more chicks but are healthier themselves and lay bigger and better eggs. Dr. Arthur D. Holmes of Boston told of the effect of feeding vitamin-rich cod-liver oil to domestic fowl, at a meeting of the American Chemical Society in Philadelphia.

Rhode Island Red pullets were given doses of cod-liver oil each day and as a result Dr. Holmes found that they laid more eggs. The eggs themselves were larger than usual and their fertility was greater. Fewer eggs contained objectionable blood spots. The greater number and size of the eggs did not make nervous wrecks of the laying hens. On the contrary they showed increased vitality and did not lose weight during the tests. They had a greater resistance to diseases, for fewer of the vitamin-fed ones died than the ones who lived on the normal hen diet alone.—*Science Service*

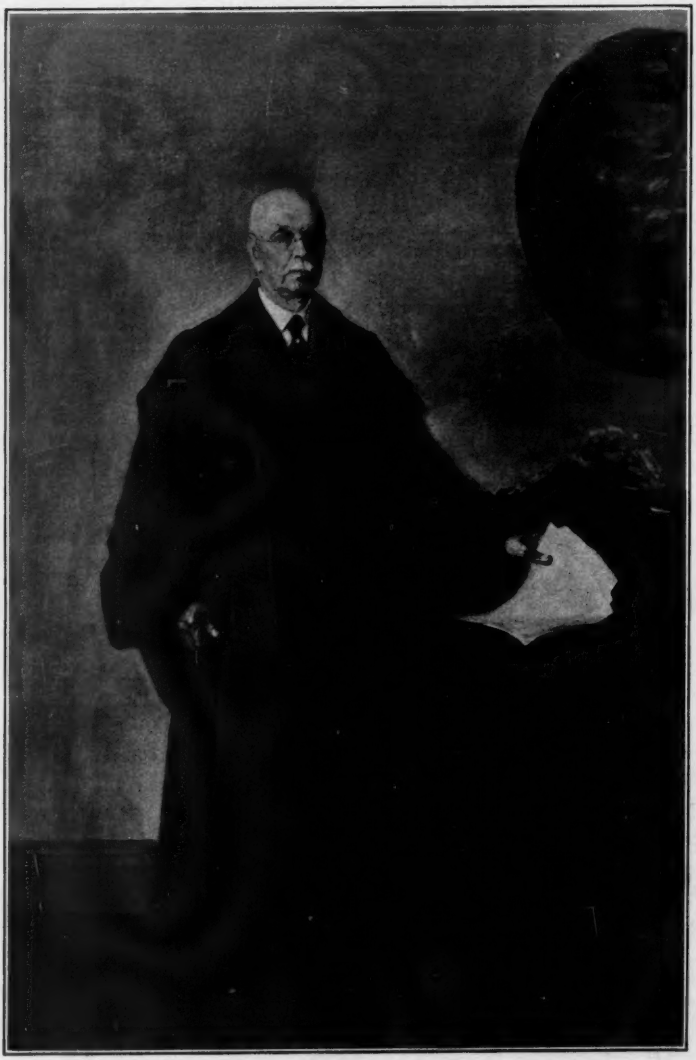
Electrons Not Smallest Things. New evidence that there is another world of almost infinite minuteness, beyond the electron which only recently replaced the atom as the smallest thing in the universe, was brought forward at Düsseldorf by Prof. Felix Ehrenhaft of Vienna University, speaking before the meeting of the Association of German Natural Scientists and Physicians. Prof. Ehrenhaft's data were obtained by means of a new and highly powerful apparatus for ultra-microscopic examination devised by himself, which makes possible the observation of particles far below the limits of ordinary microscopic visibility, floating freely in a gaseous atmosphere in a magnetic field.

He observed in this magnetized sub-microscopic field the behavior of globular bits of gaseous selenium with diameters of only one two-hundred-fifty-thousandth of an inch. Their rate of drift, under the influence of the magnet, indicated that the electrical charges they carried were less than the equivalent of one electron. This would indicate, according to Prof. Ehrenhaft, that the electron is subdivisible and, therefore, that something smaller than the electron exists.—*Science Service*

Germans Make Wool from Pine Needles. Chemically treated pine needles have worked out in Berlin as a substitute for wool for certain purposes very successfully. By varying the process a woolly product is obtained that comes either in the shape of fine sheet wadding or in soft fleeces that are used to stuff mattresses. The pine wool has fine, strong fibers not unlike hemp, and finds its best use when woven into heavy materials such as carpets and horse blankets.

The new process has a valuable asset in one of its by-products that results from the chemical treatment necessary to remove the resin from the needles. The sticky residue is shaped into resinous briquettes which have a very high fuel value and which have found a ready use in the manufacture of artificial illuminating gas.—*Science Service*

Russians Discover Potash Deposits. Potash deposits in the district of Solikamsk, government of Perm, are declared by Soviet chemists to be Russia's delivery from the Franco-German fertilizer monopoly controlled through the Stassfurt beds, hitherto the world's principal source of this important mineral. The Russian deposits, it is stated, are found over an area almost a thousand square miles in extent, and beds capable of being mined exist as close to the surface as 300 feet.—*Science Service*



PORTRAIT OF DR. IRA REMSEN BY HIS SON, PRESENTED TO JOHNS HOPKINS UNIVERSITY

EDITOR'S OUTLOOK

ALL who have enjoyed the privilege of membership in the classes to which Ira Remsen delivered his inimitable lectures will welcome this month's frontispiece as the likeness of a revered friend and a reminder of his stimulating influence. To sit at the feet of this great teacher was to go forth into the world with a firm conviction that life is well worth the living and that chemistry conceals secrets worthy of the pursuit of any young man or young woman. He exemplifies to a high degree those qualities of mind, character, and personality which add the vital spark of inspiration to the common-place processes of instruction and which are combined in one man with such lamentable rarity.

Ira Remsen

Dr. Remsen's educational leadership was not, however, confined to his lectures and to his text-books, but found outlet, also, in his administrative activities as president of Johns Hopkins University. During the thirteen years for which he served in that capacity his strong character, keen, analytical mind, and sound educational principles carried the institution steadily forward in the face of great difficulties. His term of office was marked by many fundamental changes, among them, the founding of the School of Engineering and the removal of the University to its present beautiful location near the edge of the city.

In spite of his heavy administrative duties he maintained his interest in chemistry and, with the aid of his assistants, added constantly to his long list of researches. In addition to all this, he founded and, for thirty-five years, edited one of our great chemical journals.

Many of the leaders who have been molding chemical thought for the past thirty or forty years were, in turn, molded by Remsen. It is safe to say that he has thus indirectly exerted an influence upon the lives and thinking of thousands of chemists and teachers of chemistry.

Dr. Remsen has now almost reached his eighty-first birthday and devotes much of his time to travel. His kindly humor, friendliness, good judgment, and fairness are still winning him new friends.

We take this opportunity of extending to him, a trifle in advance, congratulations upon the addition of one more year to useful and honorable life and the sincere hope that the year 1927 will bring to him many of the pleasures and satisfactions which his admirers will agree are justly his by desert.

THE beginning of a new year invites an inspection of the problems which confront our profession and some consideration of their relative degrees of importance. Today chemical education has many problems, a number of them acute, but the proper training of teachers

is one which, because of its fundamental nature and far-reaching implications, may well take first rank. In the final analysis the teacher is the pivot around which the educational system revolves. Teachers pass on and many of them are forgotten but the results of their efforts, good, bad, or indifferent, endure.

Professional Training for Teachers

In the preceding note we have paid tribute to a great chemist and a great teacher—one who has exerted an incaluable influence upon American chemistry. He is one of a notable group of "born teachers"—men who through force of individual personality and an instinct for instruction are capable of brilliant success in their chosen profession whether or no they are trained in its principles or have consciously evolved a philosophy upon which to base their teaching. Every educator and friend of education earnestly prays for an increase in their number, but from the administrative standpoint we are forced to admit that they are happy accidents. They are what the biologist terms "sports," arising from some fortunate but unknown coincidence of causes not reproducible at will. We must depend upon other sources for the great majority of our teachers.

Yet while genius may remain beyond our power to analyze or produce, it is not too optimistic to maintain that a reasonable degree of natural aptitude enhanced by training and coupled with earnest effort can attain to a fairly practical substitute therefor. Our art schools do not create Raphaels but they do turn out competent artisans and even artists in creditable quantities.

Our first problem, then, is to attract into the profession those with some degree of talent and with a natural liking for teaching. One of the most obvious means, and one which has been proposed hitherto, is that of offering suitable financial rewards. It may be contended that the young man who really loves teaching will choose it and cling to it in spite of poverty, yet the fact remains that the prudent young man will, like the prudent maid, carefully guard his affections against entanglements which promise to lead to penury and want. Only the incurably romantic in either case fail to do so. As a result the teaching profession contains even fewer than its proper proportion of recruits who choose their work for the love of it. The vast deficit is made up mainly from those who see in their jobs nothing more than a means of getting a living. In this latter class, the popular belief that the thousand-dollar man naturally drifts into the thousand-dollar job is well founded. A consideration of the average salary scale among teachers and professors makes the logical conclusion brutally obvious.

Nor can this state of affairs be attributed solely to popular ignorance and apathy. Educators contrive to wring from parsimonious legislatures and beg from philanthropic donors the wherewithal for the construction and maintenance of magnificent physical plants. If they

were, themselves, sufficiently desirous of personnel improvement they could accomplish much more than they do.

In the universities it has long been the practice to offer the juicier plums to men with a bent for research who could be counted upon to secure publicity for the institution. The fact that many of these men cannot teach and that they grudgingly go through the motions in order to gain an opportunity to do research work is never given serious consideration. Fortunately, the light is beginning to penetrate. The presidents of at least two prominent universities have already announced that they intend to consider teaching ability among the qualifications which condition the promotion of professors.

None of what we have just said should be construed in derogation of the research man, nor as a contention that the successful research worker cannot also be an able teacher. It is merely a protest against the injustice and folly of forcing the man who is primarily interested in research to teach, and of forcing the man who is primarily a teacher to do research work that he may look forward to promotion.

But there is another popular fallacy which pervades the entire educational system and which seems to be more firmly rooted in the colleges and universities than elsewhere. That fallacy is that, in order to teach a dog tricks, it is only necessary to know more than the dog. Mastery of subject-matter is practically (if not theoretically) the sole essential qualification for a professor, so far as his actual teaching is concerned. Once men with a talent for education are attracted to the profession the next task should be to train them for their chosen work.

The requirement of courses in educational principles and methods for instructors is a natural step in that direction and one which could be taken without any revolutionary disruption of the present system. Yet this will not in itself satisfactorily meet the need. We discovered some time ago that the old ideas of formal discipline were based upon misconception and faulty reasoning. We are beginning to realize also that method is not, as Dr. Thayer[1] puts it, "A procedure having a general validity independently of a particular subject-matter." We need, therefore, to add, not courses in methods of instruction, but courses in methods of chemical instruction. Such courses might be the result of coöperation between the departments of chemistry and education or they might be worked out wholly within the chemistry department. Local conditions would determine the most feasible plan at any institution. Needless to say, these courses should include supervised practice.

However, there are difficulties to be overcome before such a plan could function with unqualified success so far as chemistry teaching is con-

[1] V. T. Thayer, "The University as a Training School for College and University Teachers," *Sch. and Soc.*, **24**, 773–9 (Dec. 25, 1926).

cerned. Many questions of content and method should be answered before entirely satisfactory courses in the teaching of chemistry can be universally offered. The Senate of Chemical Education has not been unmindful of this fact. The tentative plan for an institute for research in chemical education presented on page 110, *et seq.*, of this issue is, in part, an attempt to deal with it. Such an institute could not hope to train the great body of instructors who will teach chemistry throughout the country. It could, however, investigate many of the problems which are demanding solution, could aid in the training of teachers who would in turn train others, and in summer terms could offer special courses to the more ambitious.

The Senators have already given this tentative plan their consideration and are desirous of receiving criticism and suggestions thereon from all interested in chemical education.

Foreign Editors

AT THE beginning of a new year, the JOURNAL is happy to announce an extension of its activities which it believes will be welcomed by its readers. The new departure is initiated by the addition to the Editorial Staff of the following Foreign Editors:

W. Lash Miller, Canada	Ernst Cohen, Netherlands
Atherton Seidell, France	Wojciech Swietoslawski, Poland
Sir James Irvine, Scotland	St. Minovici, Roumania
F. G. Donnan, England	E. Moles, Spain
N. Parravano, Italy	W. D. Treadwell, Switzerland
K. Freudenberg, Germany	F. Lambermont, Belgium

These men, prominent in their respective fields and keenly interested in chemical education, have agreed to contribute occasional articles on chemical and educational developments in their respective countries.

Because of characteristic national differences in educational systems and social customs, foreign methods are seldom bodily transferable to American institutions. We believe, however, that there is much in foreign education which may be suggestive of improvements in our own methods. Certainly no teacher who aspires to a mastery of his profession can afford to limit his knowledge to the systems in vogue in his own country. Nor should he remain ignorant of the part which chemistry is playing in the industrial development of other nations.

Naturally, the JOURNAL can devote but a comparatively small amount of space to material calculated to fulfil these needs. It has, therefore, exercised considerable care in the selection of representatives who might be counted upon to insure that the material published shall be the best obtainable. It considers itself singularly fortunate that the men already mentioned should have consented to act in this capacity.

PHOTOGRAPHY AS A RECORDING MEDIUM FOR SCIENTIFIC WORK.* PART I

G. E. MATTHEWS AND J. I. CRABTREE, RESEARCH LABORATORIES, EASTMAN KODAK COMPANY, ROCHESTER, N. Y.

I. Introduction

Although the majority of scientific workers utilize photography for illustrative purposes, a survey of the literature shows that only a limited number fully appreciate its usefulness as a means for recording data. For general recording work, involving only qualitative measurement, photography offers a simple, effective method of reproducing data. In this type of work it is only necessary to have a general knowledge of the classes of sensitive materials and the methods of processing them. When quantitative work is contemplated, however, it is very important that the investigator have a thorough knowledge of the properties and limitations of the photographic emulsion or the results may be falsely interpreted. This is especially true in any experimentation involving measurement of light intensities, such as photometry or astronomical work. It is obviously impossible, however, in a short paper to give a thorough discussion of the characteristic properties of the photographic emulsion. These have been dealt with at length in various papers and monographs to which those interested are referred.[1]

The purpose of this paper is to suggest the different ways in which photography may be used to record scientific observations and to describe a number of examples showing to what extent it has already been utilized. Practical suggestions on the choice of sensitive materials and methods of using and processing them are included.

II. The Adaptability of Photography for Recording Purposes

The simplest photographic records are pictures of apparatus or experiments under observation. These may take the form of records of stages of construction of interest only to the experimenter, or they may be illustrations of finished and working apparatus. The progress of an experiment may be recorded by making a series of still photographs at definite intervals, though if a large number of such photographs is desired this is best accomplished by means of a motion picture camera connected with a

* Delivered before the Division of Chemical Education of the A. C. S. at Philadelphia, September 7, 1926.

[1] "Photography as a Scientific Implement," p. 103, Van Nostrand, New York, 1923; "Photographic Researches of Hurter and Driffield," Ferguson, Royal Photographic Society, London, 1920; "Instruction in Photography," Abney, 11th edition, Iliffe & Sons, Ltd., London, 1905; Brown, *Brit. J. Phot.*, 68, 335 (1921); Thorne Baker, *et al.*, *Phot. J.*, 49 (N.S.), 181 (1925); Mees, *Phot. J.*, 48 (N.S.), 311 (1924); *J. Frank. Inst.*, 201, 525 (1926); Wilsey and Pritchard, *J. Optical Soc. Am.*, 12, 661 (1926).

"time-lapse" apparatus which makes successive exposures at any desired interval.[2] Each picture frame of the film may be subsequently enlarged to produce stills,[3] or on projection of the film the entire progress of the experiment may be viewed in the course of a few minutes whereas the actual experiment may have occupied several weeks. It should be noted that in this field the new narrow width (16 mm.), film[4] is very valuable because the total cost involved is only about one-fifth that of standard 35 mm. film.

By means of the photographic emulsion rapid physical and chemical phenomena may be quickly recorded to be examined later with more deliberation. Photographic records largely eliminate personal errors and enable a series of observations to be made more rapidly than visually, especially when recording simultaneously two or more phenomena.

The photographic emulsion offers the only means of accurately recording many reactions invisible to the eye. It also finds important applications for integrating radiations over long periods and for measuring their intensity.

III. Examples of the Use of Photography as a Recording Medium

1. GENERAL REFERENCES

The book, "Photography as a Scientific Implement,"[5] deals with the use of photography in astronomy, engineering, metallurgy, surveying, and aeronautics. A chapter discussing the theory of photographic processes and methods is included.

"Photographie in Wissenschaft und Technik"[6] (four volumes) contains 500 illustrations and many references. Vol. 1 discusses applications of photography in physics, chemistry, astronomy, astrophysics, meteorology, mineralogy, and geology. Vol. 2—botany, zoölogy, physiology, anatomy, surgery, and pathology. Vol. 3—photogrammetry, balloon photography, and engineering. Vol. 4—topography and anthropology.

"Applications Scientifiques de la Photographie,"[7] treats the technic of scientific photography with applications in the study of falling bodies, capillarity, hydrodynamics, heat, acoustics, optics, electricity, meteorology, and chemistry.

"The Camera as a Historian,"[8] describes the use of photography in the

[2] Green, *Trans. Soc. Motion Picture Eng.*, **26**, 147 (1926).
[3] Hickman, *Ibid.*, **25**, 49 (1926).
[4] Mees, *Ibid.*, **16**, 252 (1923).
[5] Van Nostrand, New York, **1923**.
[6] Wolf-Czapek, Union Deutsche Verlags Ges., Berlin, **1911**.
[7] Niewenglowski, Gauthier-Villars et fils, Paris.
[8] Gower, Just and Topley, Low, Marston & Co., London, **1916**.

making of surveys and the methods of classification and storage of photographic records.

In Watkins' book, "Photography,"[9] several chapters are devoted to a description of scientific applications of photography.

The following books deal with scientific uses of motion pictures: "Le Cinematographe Scientific et Industriel;"[10] "Wissenschaftliche Kinematographie;"[11] "Der Film in der Technik;"[12] and "Moving Pictures, How They Are Made and Worked."[13]

General articles have been written by Graff,[14] Eldridge,[15] and Clark.[16]

2. PHOTOGRAPHY IN CHEMISTRY

A. Physical Chemistry

(*a*) *Rate of Reaction.* Latshaw and Patrick[17] have described an instrument for recording pressure changes (indicated by a liquid manometer) on a photographic film at much shorter intervals than would be possible by direct reading of the manometer. The film (20 cm. wide) was wound on a drum enclosed in a box, light-tight except for a slit which held the manometer. Illumination was furnished by an arc lamp and a mirror directed a narrow beam on the meniscus.

(*b*) *Sedimentation and Emulsification.* A series of papers have been published by Svedberg and his associates,[18] Nichols, Rinde, and Stamm which describe the construction of an ultra-centrifuge with a camera attachment making possible the determination of the rate of movement outward of the boundary of particles of very fine-grained sols. (See Fig. 1). By this means it is possible to obtain size-distribution data on particles of colloidal dimensions. Lambert and Wightman[19] have also devised an apparatus for recording the weight or size-frequency distribution of particles in a sedimenting liquid. A curve showing the position of the meniscus of a capillary is automatically plotted on a moving strip of bromide paper.

(*c*) *Brownian Movement.* V. Henri[20] made motion pictures of the Brownian movement of rubber latex particles in 1908. Several years later,

[9] Constable & Co., Ltd., London, **1918.**

[10] Librairie des Sciences et de L'Industrie, Paris, **1911.**

[11] Liesegang, Kieser, and Polimanti, Liesegang, Dusseldorf, **1920.**

[12] Thun, Verein Deutsche Industrie, Berlin, **1925.**

[13] Talbot, Lippincott, Philadelphia, Pa., **1923.**

[14] *J. Ind. & Eng. Chem.*, **9**, 1052 (1917).

[15] *The Camera*, **29**, 145 (1924).

[16] *Phot. J.*, **48** (N.S.), 465 (1925).

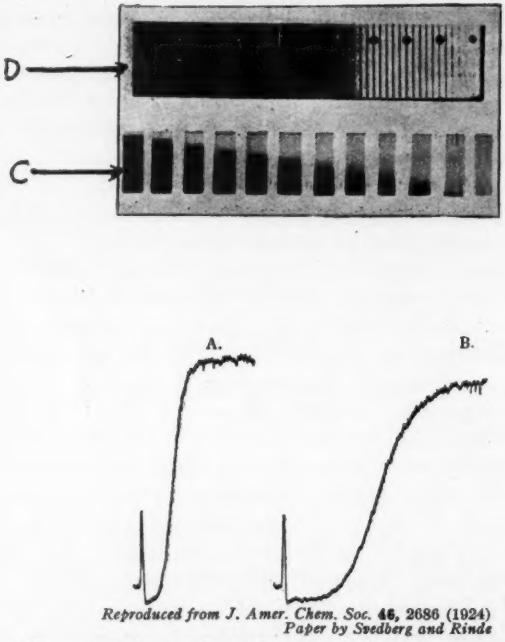
[17] *J. Am. Chem. Soc.*, **47**, 1202, 1207 (1925).

[18] *J. Am. Chem. Soc.*, **45**, 943, 2910 (1923); *Ibid.*, **46**, 2677 (1924); *Ibid.*, **47**, 1582 (1925); Colloid Sym. Mono., **III**, 251, 268 (1925).

[19] *J. Optical Soc. Am.*, **11**, 393 (1925).

[20] *Soc. Franc. de Phys. Bull. des Sci.*, **4**, 45, 61 (1908).

Drake, McBain and Salmon[21] used the motion picture camera as an aid in studying the formation and change of structure of various soaps. Kraemer[22] has discussed the advantages of the kinoultramicroscope over visual measurements in the study of Brownian motion. The use of a small motion picture camera taking narrow width (16 mm.) film has been



Reproduced from J. Amer. Chem. Soc. **46**, 2686 (1924)
Paper by Svedberg and Rinde

FIG. 1.—Record Obtained with Svedberg's Ultracentrifuge. *C* is the photograph of the meniscus line of the sol taken at different intervals as the boundary line moved outward. *A* and *B* are curves constructed from microphotometric records giving the relation between the concentration of the sol being centrifuged and the distance from the axis of rotation. *D* is a calibration record. Photographs made with centrifuge operating at 5700 r.p.m. See reference 18, p. 11.

described by Wightman and Trivelli[23] in the determination of the shape and movement of rubber latex particles.

(*d*) *Cataphoresis.* By taking advantage of the high fluorescence of certain proteins when subjected to a powerful source of ultra-violet radia-

[21] *Proc. Roy. Soc.* (London), **98A**, 395 (1921).
[22] Colloid Sym. Mono., **II**, 57 (1924).
[23] *Ind. Eng. Chem.*, **17**, 164 (1925).

tion, Svedberg and Jette[24] have devised a photographic method of recording cataphoresis phenomena. Filters passing light at 366 $\mu\mu$ were used. A later paper by Scott and Svedberg[25] describes refinements in the experiments resulting in better photographs.

(*e*) *Molecular Weight Determination.* The molecular weight of complex substances such as proteins has recently been determined by Svedberg and Fahraeus.[26] Samples of the solutions (hemoglobin) were placed in small cells in an ultra-centrifuge and photographed when exposed to a centrifugal force up to 5000 times the force of gravity.

(*f*) *Surface Tension.* From motion picture records of the formation of drops of a liquid in an atmosphere of its own vapor, Moluduii and Pavlov[27] have been able to obtain measurements from which they were able to calculate the surface tension of the liquid.

(*g*) *Rarefaction of Gases.* Valle[28] has described an apparatus for photographing the moving column of an electric discharge and has suggested the character of the picture as a means of identifying the rarefaction of the gas.

(*h*) *Detection of New Elements.* The recent discovery of Illinium by Harris and Hopkins[29] is a further illustration of the great value of the spectroscope aided by the photographic emulsion for determination of new elements and the study of their properties. Wilson's[30] fog tracks of alpha particles and Harkins'[31] study of zeta rays represent novel applications of photography in the study of the disintegration of the elements.

(*i*) *Kinetic Theory and Atomistics.* All physico-chemical research involving the use of X-rays is largely dependent on photography for recording the results. Much of W. H. and W. L. Bragg's[32] work on X-ray spectra was recorded on a photographic plate, as were also the beautiful crystal patterns predicted by von Laue and actually demonstrated by Friedrich and Knipping.[33] The powder method of crystal analysis developed by Debye and Scherrer[34] and independently by Hull[35] uses photographic film to record the reflected radiations. In this method, the film is placed

[24] *J. Am. Chem. Soc.*, **45**, 954 (1923).
[25] *Ibid.*, **46**, 2700 (1924).
[26] *Ibid.*, **48**, 430 (1926).
[27] *Bull. Acad. Sci. Russ.*, **1920**, p. 241; *C. A.*, **19**, 1646 (1925).
[28] *Nuovo Cimento* (N.S.), **1**, 99 (1924); *C. A.* **19**, 214 (1925).
[29] *J. Am. Chem. Soc.*, **48**, 1585 (1926).
[30] *Ibid.*, **37**, 1367 (1915).
[31] *Ibid.*, **45**, 2095 (1923).
[32] "X-rays and Crystal Structure," Bell & Sons, Ltd., London, **1924**.
[33] *Ber. Bayer Akad. Wiss.* (Math.-phys. Kl.) **1912**, 303; *Ann. der Phys.*, **41**, 971 (1913); *Le Radium*, **10**, 47.
[34] *Kgl. Ges. d. Wiss. Göttingen*, Dec., **1915**; *Phys. Zeit.*, July **1**, **1916**, p. 277.
[35] *Phys. Rev.*, Jan., **1917**, p. 85.

so that it intercepts the reflected rays and records the beams corresponding to any given face and order of reflection as a series of halos surrounding the central image. Other general discussions of the subject have been published by Wyckoff[36] and Davey.[37]

A most valuable application of photography with relation to atomic analysis is described by J. J. Thomson in his book, "Rays of Positive Electricity."[38] The photographic plate is used to determine the mass and velocity of a stream of positively charged protons which are caused to form parabolic curves by passing them through electrostatic and electromagnetic fields. Subsequently, Aston[39] improved on Thomson's method in the design of a mass spectrograph which uses a photographic plate for recording the separation of the isotopes of the elements.

B. Organic Chemistry

A cinematographic representation of chemical synthesis has been made by Fourneau[40] who suggests that animated representations of complex organic reactions may be of considerable value in presenting a subject of this nature. H. T. Clarke of the Eastman Research Laboratories has prepared a film showing both schematic and actual preparation of several organic compounds.

Certain organic reactions produce a characteristic luminescence which may be measured photographically. Evans and Dufford[41] have described the use of a plate holder with a series of slits covered with different monochromatic filters for determining the color of the luminescence of *p*-bromophenylmagnesium bromide and related compounds. Fluorescent spectra were also obtained but they were unable to get a record of the chemi-luminescence spectrum even with 10 hours' exposure. Later papers by Dufford, Calvert, and Nightingale[42] give further results.

The recording of selective absorption of organic compounds with particular reference to the determination of the relation of structure to constitution has been an important application of the photographic emulsion. Books by Kayser,[43] Baly,[44] Watson,[45] and Martinet[46] give descriptions of the methods and bibliographies.

[36] "The Structure of Crystals," The Chem. Catalog Co., Inc., New York, **1924.**

[37] *Gen. Elec. Rev.*, **27,** 742, 795 (1924); *Ibid.*, **28,** 129, 258, 342, 586, 721 (1925); *Ibid.*, **29,** 118 (1926).

[38] Longmans, London, **1921.**

[39] "Isotopes," E. Arnold & Co., London, **1922.**

[40] *Recherches inventions*, **1924,** p. 690.

[41] *J. Am. Chem. Soc.*, **45,** 278 (1923).

[42] *Ibid.*, **45,** 2058 (1923); *Ibid.*, **47,** 95 (1925); *J. Optical Soc. Am.*, **9,** 405 (1924).

[43] "Handbuch der Spectroscopie," Vols. 1–5, Hirzel, Leipzig, **1910.**

[44] "Spectroscopy," Vol. I, Longmans, London, **1924.**

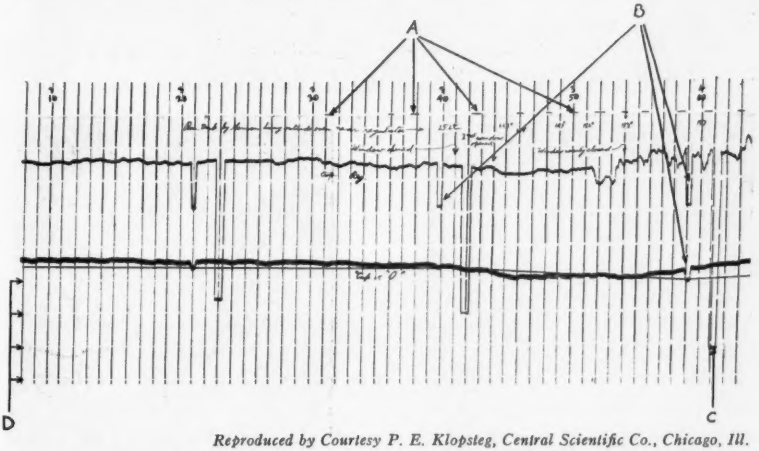
[45] "Color in Relation to Constitution," Longmans, London, **1918.**

[46] "Couleur et Constitution Chimique," Octave Doin, Paris, **1924.**

C. General, Quantitative and Industrial Chemistry

(*a*) *Luminescence.* Weiser's[47] papers are among those first published recording the results of methods devised to measure photographically the color of faint luminescence. His method consisted in simply exposing a slide containing the photographic plate, covered with a series of filters, to the radiation given off by the substance.

(*b*) *Gas Absorption.* Ledig and Weaver[48] used a strip of bromide paper wound on a cylinder and exposed by means of a slit and a shutter



Reproduced by Courtesy P. E. Klopsteg, Central Scientific Co., Chicago, Ill.

FIG. 2.—Automatic Temperature Control Record of Electrically Heated Apparatus. Since this record is made by application of the galvanometer principle, a greater degree of precision is possible than if it was traced by some mechanical means. Distance between vertical lines represents one-minute intervals. Two simultaneous records are shown, the lines being of different width for easy differentiation. The short lines marked "A" indicate when and how long heating element was "on" and "off." "B" shows how galvanometer zeros are automatically checked every 20 minutes. Two minutes after zeros are checked, the potentiometer current is also checked as shown at "C." "D" are calibration points representing any desired intervals from 0.005°C., up. In the illustration, 1°C. intervals are shown. See reference 49, below.

to record the movement of a thread of solution in a capillary thus measuring the pressure of a gas in a closed system.

(*c*) *Temperature Measurement.* Automatic records of temperature changes may be made by using an apparatus described by Stannard and Klopsteg.[49] The record is produced by directing spots of light from two reflecting galvanometers operating in conjunction with a thermocouple.

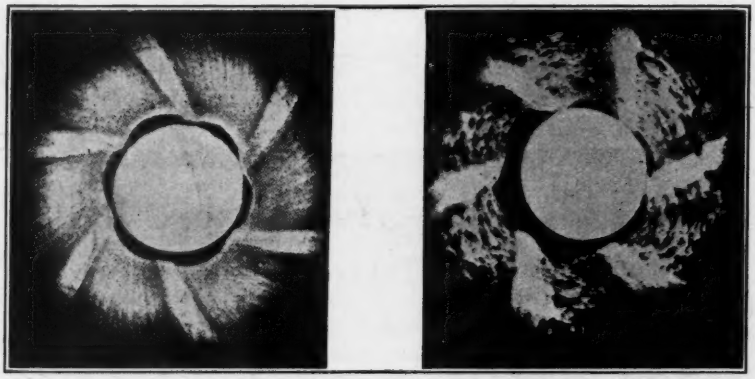
[47] *J. Phys. Chem.*, **22**, 439, 480, 576 (1918); *Ibid.*, **25**, 61, 349, 473 (1921).

[48] *J. Am. Chem. Soc.*, **46**, 650 (1924); *Ind. Eng. Chem.*, **16**, 1231 (1924).

[49] *J. Optical Soc. Am.*, **9**, 587 (1924).

A timing record is also made and the paper automatically processed. (See Fig. 2.)

(*d*) *Measurement of Corrosion.* S. Nakamura[50] has described a special camera for photographing the interior of a rifle barrel and has shown the value of such records in studying the rate of deterioration of the barrel. (See Fig. 3.) Another type of camera has been designed independently by Gardner and Case[51] which gives a linear record of the entire length of the rifle barrel by means of a spiral mechanism. The progress of corrosion of cast aluminum alloys has been effectively shown by Zimmerman[52] with the aid of successive photographs. The rate of corrosion of monel metal in photographic fixing solutions has been determined photographically by Crabtree and Matthews.[53]



Reproduced from Brit. J. Phot. **73**, 19 (1926)
Paper by S. Nakamura

Uncorroded Corroded

FIG. 3.—Photographs of Interior of Rifle Barrel. Left picture shows a new uncorroded barrel. Right picture shows condition of barrel after use, indicating pitted condition. See reference 50, below.

(*e*) *Growth and Solution of Crystals.* France[54] used a small motion picture camera taking narrow width (16 mm.) film to study both microscopically and macroscopically the growth and solution of individual crystals. References are made in his paper to other examples of the use of photography for recording purposes. A later paper[55] deals with a

[50] *Brit. J. Phot.*, **73**, 19 (1926).

[51] *J. Optical Soc. Am.*, **12**, 159 (1926); see also Davis, *Sci. Paper* No. **517**, U. S. Bur. Standards.

[52] *Ind. Eng. Chem.*, **17**, 359 (1925).

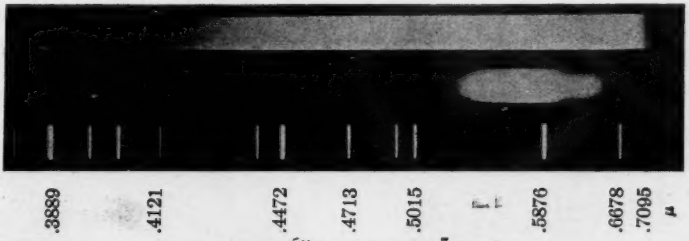
[53] *Ibid.*, **16**, 671 (1924).

[54] Colloid Sym. Mono., **III**, 317 (1925).

[55] *J. Am. Ceram. Soc.*, **9**, 67 (1926).

Cine ultra-microscopic study of the relation of colloidal content and plasticity in clays.

(*f*) *Industrial Chemical Processes.* Many interesting motion picture films have been made describing chemical processes used by different industrial firms. Lists of the available films have been published since



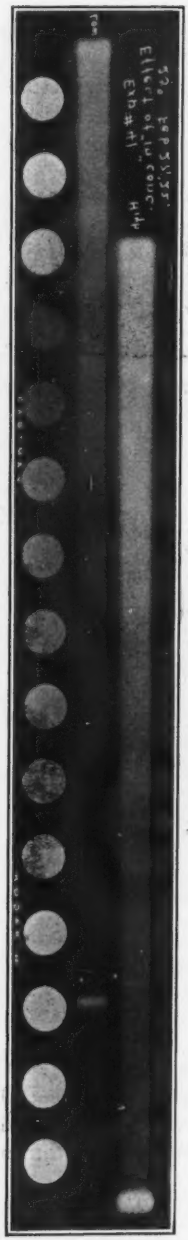
A—Spectrum of "4 watt" carbon glow lamp.
B—Spectrum of firefly, "Photinus pyralis."
C—Helium vacuum tube spectrum.

Reproduced from Bull. U. S. Bur. Stand. **6** (1909–1910) *Paper by Ives and Coblentz, p. 321*

FIG. 4.—Luminescence Spectrum and Fluorescence Spectrum of Firefly. Such records require very long exposures (several hours) because of the low intensity of the radiation. See reference 61, p. 18.

1922 in *Industrial and Engineering Chemistry,* also in *The Educational Screen,* and in a catalog called *Motion Pictures* issued by the General Electric Co. Kent[56] has prepared a summary of the experiments conducted on the value of industrial motion picture films in science courses at an industrial institute.

[56] *Visual Educ.,* **5,** 70, 141 (1926).



Reproduced by Courtesy, W. R. Amberson, Univ. of Penn., Phila., Pa.

FIG. 5.—Luminescence Record of Rate of Decay of Cypridina Enzyme. The two strip exposures are the decay records and the circles represent a calibration measurement. See reference 62, below.

(g) *Flame Propagation.* Mallard and Le-Chatelier[57] photographed the passage of a flame through an explosive mixture held in a vertical tube. Other photographic studies of flame propagation have been made by Dixon,[58] Foley and Souder,[59] and Midgley.[60] The last-named author found the photographic record a valuable means of studying anti-knock compounds.

D. Bio-Chemistry and Related Sciences

Ives and Coblentz[61] were successful in making measurements of the luminous efficiency of the low intensity light given off by the firefly. Neither a radiation meter nor a spectrophotometer were sensitive enough to record this radiation but by holding the insects before the slit of the spectrograph successively for two to six hours, records could be made on a panchromatic plate. A fluorescent spectrum of an excretion from the firefly was also obtained. (See Fig. 4.) Amberson[62] has made a critical analysis of the limitations of the photographic medium for recording animal luminescence. Two-thirds of a film strip was used for measuring the rate of decay of an aqueous solution of the enzyme and the remaining third for a calibration exposure by means of a series of 15 filters of nearly neutral density. (See Fig. 5.)

The microscope combined with the camera has served as a valuable means of recording bio-chemical data for many years and general text-books on the subject have been written by Hind and Randles,[63] Beck,[64]

[57] *Compt. rend.*, **91**, 825 (1880); **93**, 145 (1881); **95**, 566 (1882); *Ann. Chem. Phys.*, (5) **28**, 289 (1883).

[58] *J. Soc. Automotive Eng.*, **9**, 237 (1921).

[59] *Phys. Rev.*, **35**, 373 (1912).

[60] *J. Soc. Automotive Eng.*, **10**, 359 (1922); also Woodbury, Lewis, and Canby, *Ibid.*, **9**, 209 (1921).

[61] *Bur. Standards Bull.*, **6**, 321 (1909–10).

[62] *J. Gen. Phys.*, **IV**, 517, 535 (1923).

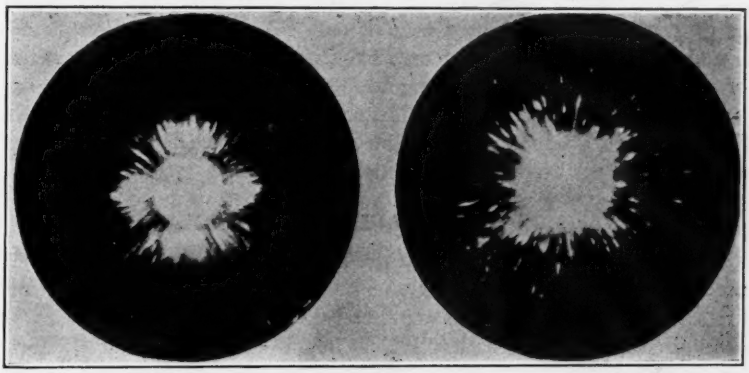
[63] "Handbook of Photomicrography," Dutton & Co., New York, **1913.**

[64] "The Microscope," Vols. I and II, Beck, Ltd., London, **1921.**

Barnard,[65] and others. By using two and three-color photography, very beautiful records may be made of stained biological specimens.[66] M. Bull, F. P. Smith, R. Ditmars, H. M. Lomas, J. E. and G. Williamson, J. Comandon, and others have made motion picture studies of plant growth, insect life, natural history, marine vegetation, microbes, etc.[67]

E. Chemi-Metallurgy

Photomicrography is of great importance in the study of metals and alloys. Although no complete text-book is known dealing specifically with the subject, Lucas[68] has published a number of articles, the most re-



Reproduced from Ind. Eng. Chem., **17**, 1142 (1925)
Paper by Clark, Brugmann and Hath

Tin plate Tin removed

FIG. 6.—Monochromatic X-ray Pinhole Diagrams. Left picture is diagram of tin plate showing tin crystals apparently deposited from the melt in oriented fashion; right diagram is same sample with the tin removed. Apparatus equipped to make 18 such diagrams simultaneously thus providing a very rapid method of analysis. See reference 69, p. 20.

cent of which discusses developments in high-power photo-metallography with various types of illumination. Sections of the following books are devoted to photomicrography: "Introduction to Metallography," P. Goerens, Longmans, London, **1908;** "Metallography," C. H. Desch, Longmans, London, **1910;** "Metallography," Part I, S. L. Hoyt, McGraw-Hill Book Co., New York, **1920;** "Physical Metallography," E. Heyn

[65] "Practical Photomicrography," Arnold, London, **1925.**

[66] "Photomicrography," 8th edit., p. 40, E. K. Co., Rochester, N. Y., **1925.**

[67] "Moving Pictures," Talbot, Chapts. 13 and 15, Lippincott, Phila., Pa., **1923;** also Comandon, *Compt. rend. soc. biol.*, **74,** 464 (1913); *Ibid.*, **75,** 457 (1913); *La presse méd.*, **1913,** p. 469; *Compt. rend.*, **LXIII,** *session asso. franc. avancement Sci.* (1914); *J. Physiol. et Pathol.*, **17,** 573 (1917); *Ann. l'Inst. Pasteur.*, **34,** 1 (1920).

[68] *J. Frank. Inst.*, **201,** 177 (1926).

(trans. by Grossman), Wiley & Sons, **1925**; "Photomicrography," Eastman Kodak Co., Rochester, N. Y., **1925.**

The use of X-rays for the determination of the composition of metals and alloys (an outgrowth of Bragg's work), has been recently described by Clark, Brugmann, and Hath.[69] The apparatus for producing monochromatic X-radiation is described and illustrations are given. (See Fig. 6.) X-ray crystallometry has been applied by Clark, Asbury, and Wick[70] to the study of the structure of nickel catalysts.

F. Photography as an Aid to Teaching Chemistry

Although lantern slides have been used for many years as a supplement to instruction in science courses, it is only recently that motion picture films have been used to any extent. Miss MacLeod[71] has stressed the value of motion pictures in chemistry and Elliott[72] has presented two papers before the Division of Chemical Education of the American Chemical Society calling attention to the value of narrow width (16 mm.) film for such work. See also reference to article by Kent.[56]

3. PHOTOGRAPHY IN PHYSICS

For certain physical measurements, photography has been extensively used during the last half century. Its use in studying crystal structure, atomic spectra, detection of isotopes and positive ray analysis has already been discussed. (See *i*, under "Phys. Chem.," page 13.) Fabry[73] has recently reviewed the application of photography as an instrument for the measurement of visible and invisible radiation in the field of celestial topography and spectro-photometry. A method of making continuous photometric density measurements which eliminates intermittency errors has been described by Jones[74] which provides that the densities to be compared shall be adjacent to one another. Müller[75] has published a description of an apparatus which simultaneously registers on a photographic plate a series of transmission curves of dye solutions or colored glasses.

In the field of mechanics, several novel applications of photography have been made. Vincent[76] has been able to obtain data on surface tension, reflections, and interference from photographs of mercury ripples. Professor Worthington's "Study of Splashes,"[77] describes the analysis

[69] *Ind. Eng. Chem.*, **17**, 1142, 1147 (1925); also *J. Optical Soc. Am.*, **12**, 379 (1926).
[70] *J. Am. Chem. Soc.*, **47**, 2661 (1925).
[71] *Visual Educ.*, p. 18, May, **1920.**
[72] Program of 68th and 71st meetings, Am. Chem. Soc.
[73] *Phot. J.*, **50** (N.S.), 328 (1926).
[74] *J. Optical Soc. Am.*, **10**, 561 (1925).
[75] *Zeit. Phys.*, **34**, 824 (1925).
[76] *Proc. Phys. Soc.*, vol. XV.
[77] Longmans, Londo.n

of rapid liquid motion produced by drops or balls falling into a shallow dish. Boys,[78] Curtis, Wadleigh, and Sellman,[79] deFeriet[80] and Quayle[81] have made some very unusual photographs of rifle bullets and other projectiles many of which record the air waves set up by the movement of the bullets. Glätzel[82] has described a great many additional uses of the electric spark in photographically recording rapid motion. S ch records may be either an actual image or a shadowgraph.

Records of cyclatory motion are frequently found in the literature. Electrical problems lend themselves very well to this type of work. Cyclatory motion may be regular and continuous or irregular and continuous about some mean position. Moss[83] describes several such records which are usually produced in one of the following ways: (1) by light reflected from a mirror on a tuning fork; (2) by an oscillograph requiring that the light beam deflected be proportional to a varying current; (3) by a string galvanometer whereby the record is produced by the deflection of a single silvered glass fiber passing between the poles of a powerful electromagnet; very weak currents causing movements of the fiber so that it constitutes an ultra-sensitive recording medium. Short oscillatory records may be obtained by allowing the photographic plate to fall at a definite speed past an opening. Longer records require the use of roll or cine film or bromide paper. Examples of these records are telephonic sound reproductions, current vibrations of a dynamo, and pressure changes in the cylinder of an engine. Seashore and Metfissal[84] have used motion pictures of sound records in the analysis of music. Other variations of oscillographic instruments have been described by Williams,[85] Trowbridge,[86] Norton,[87] and Terroux.[88] (See Fig. 7.) Additional examples of pressure recording apparatus will be described under the section on engineering.

Both Rankine[89] and DeForest[90] have experimented on the reproduction of sound as density records on motion picture film; the latter devising a method of incorporating the record along the edge of the film so that it may be used in synchronization with the picture.

[78] *Nature,* Vol. XCVII. See also "Photography as a Scientific Implement," Van Nostrand, N. Y., **1923,** p. 266; *J. Camera Club* (London) **V,** 94 (1891).

[79] *Tech. Paper,* No. **255,** U. S. Bur. Standards.

[80] *Science ind.*, **5,** R., 191 (1925).

[81] *Sci. Paper,* No. **508,** U. S. Bur. Standards.

[82] F. Vieweg & Sohn, Braunschweig, **1915.**

[83] "Photography as a Scientific Implement," Van Nostrand, New York, **1923,** p. 267.

[84] *Sci. Service,* **VII,** No. 228 (1925).

[85] *J. Optical Soc. Am.*, **9,** 129 (1924).

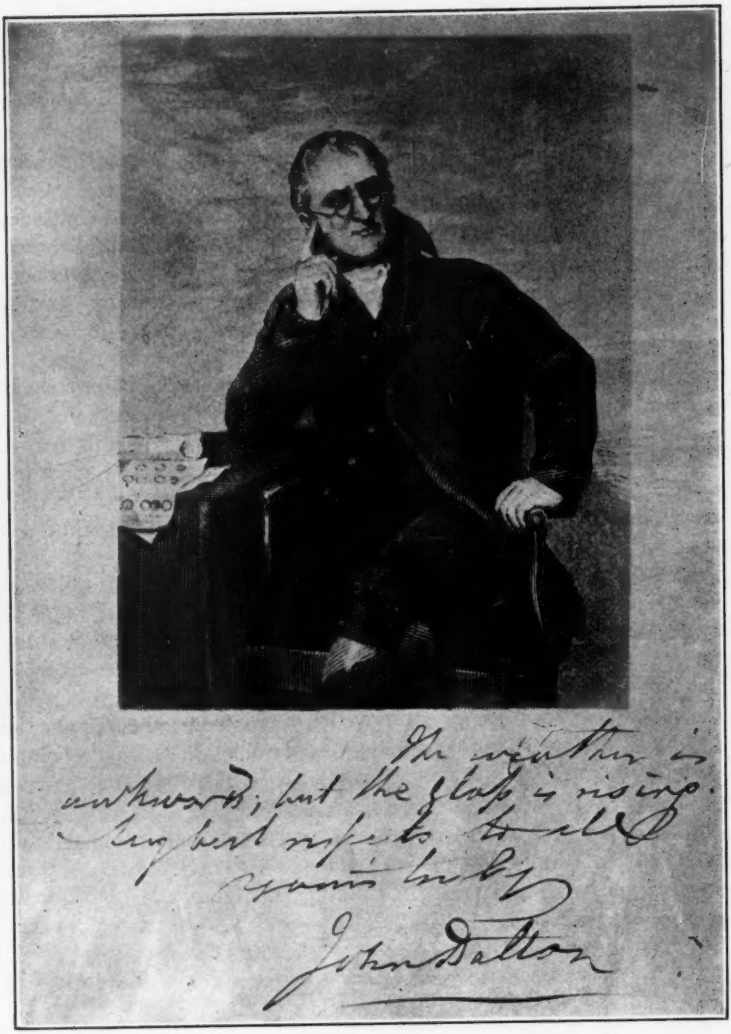
[86] *Ibid.*, **9,** 557 (1924); also *J. Soc. Automotive Eng.*, **10,** 351 (1922).

[87] *J. Frank. Inst.*, **198,** 231 (1924).

[88] *Ibid.*, **200,** 771 (1925).

[89] *Proc. Phys. Soc.* (London), vol. XXXII.

[90] *Trans. Soc. Motion Picture Eng.*, **16,** 61 (1923); also *Phot. J.*, **49** (N.S.), 243 (1925).


The weather is
awkward; but the glass is rising.
My best respects to all
yours truly
John Dalton

JOHN DALTON (B. 1766, D. 1844)*

The Early Years of the Atomic Theory as Illustrated by Dalton's Own Note-Books and Lecture Diagrams. His Apparatus

H. F. COWARD, MINES RESEARCH LABORATORIES, SHEFFIELD, ENGLAND

Important Dates

1803. Sept. 6. First recorded list of atomic weights; in manuscripts in Dalton's note-book.

1803. Oct. 21. First public announcement of determinations of "the relative weights of the ultimate particles of gaseous and other bodies," at a meeting of the Manchester Literary and Philosophical Society (England). Published in 1805 in the *Memoirs* of that Society. This gave a list of 21 substances, elements, and compounds, with the relative weights of their ultimate particles, without explanations as to the mode of their derivation.

1807. Spring. Lecture tour to Edinburgh and Glasgow, where Dalton expounded the new theory. .

1807. Thomas Thomson. *System of Chemistry*. Contains an exposition of the theory, as given by Dalton to Thomson.

1808. *New System of Chemical Philosophy*, vol. 1, part 1, published. Contains (p. 214) general rules for guiding the choice of the appropriate formulas for compounds; also a list of atomic weights and 37 examples of the symbolic representations of simple and compound "atoms."

1810. *New System of Chemical Philosophy*, vol. 1, part 2.

1827. The same, vol. 2, part 1. Contains a considerably revised list of the relative weights of ultimate particles.

The story of John Dalton's life has been told by his biographers, William C. Henry, "Life and Scientific Researches of John Dalton," **1854**, and R. Angus Smith, "Memoir of John Dalton," **1856**, and in an especially interesting way by Sir Henry Roscoe ("John Dalton and the Rise of Modern Chemistry," Macmillan and Co., **1895**), who recounts the steps by which Dalton arrived at the formulation of the fundamental theory of chemical science, the atomic theory.

Origin of the Atomic Theory

During the greater part of last century it was generally thought by chemists that Dalton had been led to enunciate the atomic theory as a

* Delivered before the joint session of the Division of Chemical Education and Section of History of Chemistry of the A. C. S. at Tulsa, Oklahoma, April 7, 1926.

deduction from the discovery of the law of multiple proportions. This idea was based on the account which Thomas Thomson gave in his "History of Chemistry" (1830–31). Thomson wrote with some authority, for he had spent some time with Dalton in 1804, discussing the atomic theory less than a year after it had been originated. He says: "Mr. Dalton informed me that the atomic theory first occurred to him during his investigations of olefiant gas and carburetted hydrogen gas, at that time imperfectly understood, and the constitution of which was first fully developed by Mr. Dalton himself. It was obvious from the experiments which he made upon them, that the constituents of both were carbon and hydrogen, and nothing else; he found, further, that if we reckon the carbon in each the same, then

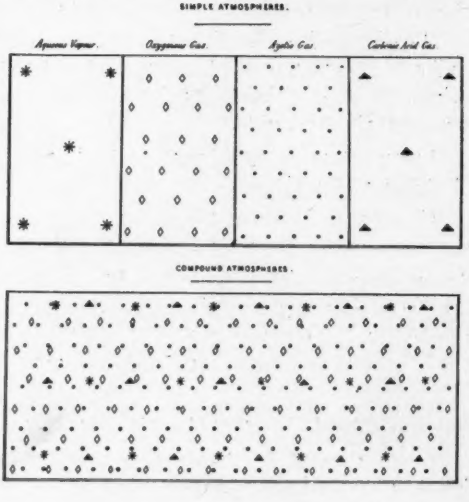
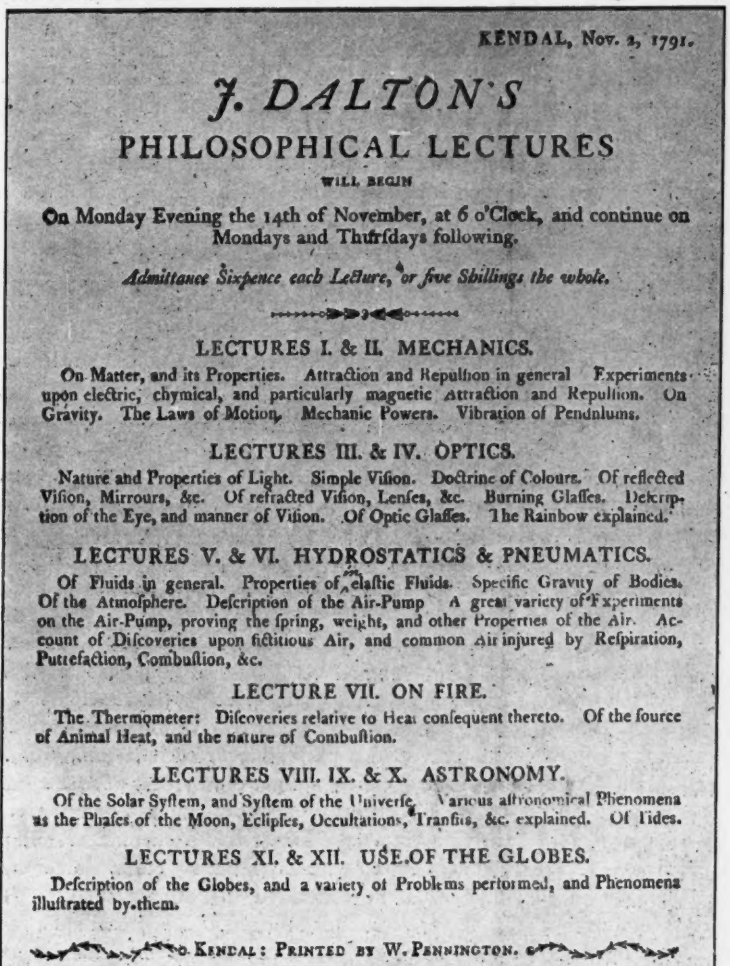


FIGURE 1

carburetted hydrogen gas contains exactly twice as much hydrogen as olefiant gas does. This determined him to state the ratios of these constituents in numbers, and to consider the olefiant gas a compound of one atom of carbon and one atom of hydrogen; and carburetted hydrogen of one atom of carbon and two atoms of hydrogen. The idea thus conceived was applied to carbonic oxide, water, ammonia, etc., and numbers representing the atomic weights of oxygen, azote, etc., deduced from the best analytical experiments which chemistry then possessed."

One of Dalton's biographers, William C. Henry, adduced some evidence at a later date (1854) that the conception of the atomic theory developed from an attempt to explain the constitution of the atmosphere; and, alternatively, that Dalton based the theory on Richter's table of equivalent

weights of acids and bases. Angus Smith (1856) ascribed importance in the origin of the theory to Dalton's discovery that nitric oxide might com-



KENDAL, Nov. 2, 1791.

J. DALTON'S

PHILOSOPHICAL LECTURES

WILL BEGIN

On Monday Evening the 14th of November, at 6 o'Clock, and continue on Mondays and Thurſdays following.

Admittance Sixpence each Lecture, or five Shillings the whole.

LECTURES I. & II. MECHANICS.

On Matter, and its Properties. Attraction and Repulſion in general Experiments upon electric, chymical, and particularly magnetic Attraction and Repulſion. On Gravity. The Laws of Motion. Mechanic Powers. Vibration of Pendulums.

LECTURES III. & IV. OPTICS.

Nature and Properties of Light. Simple Viſion. Doctrine of Colours. Of reflected Viſion, Mirrours, &c. Of refracted Viſion, Lenſes, &c. Burning Glaſſes. Deſcription of the Eye, and manner of Viſion. Of Optic Glaſſes. The Rainbow explained.

LECTURES V. & VI. HYDROSTATICS & PNEUMATICS.

Of Fluids in general. Properties of elaſtic Fluids. Specific Gravity of Bodies. Of the Atmoſphere. Deſcription of the Air-Pump A great variety of Experiments on the Air-Pump, proving the ſpring, weight, and other Properties of the Air. Account of Diſcoveries upon fictitious Air, and common Air injured by Reſpiration, Putrefaction, Combuſtion, &c.

LECTURE VII. ON FIRE.

The Thermometer: Diſcoveries relative to Heat conſequent thereto. Of the ſource of Animal Heat, and the nature of Combuſtion.

LECTURES VIII. IX. & X. ASTRONOMY.

Of the Solar Syſtem, and Syſtem of the Univerſe. Various aſtronomical Phenomena as the Phaſes of the Moon, Eclipſes, Occultations, Tranſits, &c. explained. Of Tides.

LECTURES XI. & XII. USE OF THE GLOBES.

Deſcription of the Globes, and a variety of Problems performed, and Phenomena illuſtrated by them.

KENDAL: PRINTED BY W. PENNINGTON.

FIGURE 2

bine with either a certain volume of oxygen, or with twice that volume.

In spite of these statements, Dalton did not base his theory on the law of multiple proportions; the opposite was the case: the law of multiple

proportions was a deduction from the theory. This has been proved by Roscoe and Harden ("A New View of the Origin of Dalton's Atomic Theory," **1896**). They found in the rooms of the Manchester Literary and Philosophical Society a set of laboratory note-books and lecture books, all in Dalton's own handwriting. The notes of a lecture delivered in 1810 include the following argument in the course of a discussion as to whether the component gases of the atmosphere were held together by chemical affinity, or merely mixed together. Dalton adopts the Newtonian idea "that an elastic fluid is constituted of small particles or atoms of matter, which repel each other by a force increasing in proportion as their distance diminishes." He pictured on paper the "atoms" of nitrogen, oxygen, and water vapor, and tried to combine them in simple numerical proportions to produce a mixture of uniform density; but without success. He then distributed the various "atoms" uniformly, in physical admixture, as he shows in Figure 1. (*Mem. Manchester Lit. Phil. Soc.*, **5** (first series), 1802). In order that the mixture thus formed should not separate into layers, under the influence of gravity, he postulated that the various atoms were each surrounded by an atmosphere of heat which caused like atoms to repel one another, but did not cause unlike atoms to repel one another; in this way only could he conceive the possibility of a uniform mixture. The atmospheres of heat round like atoms had to be all equal, and different in size from the atmospheres round the atoms of another substance. Dalton thereupon determined to find the relative sizes of the atoms of the gases of the atmosphere, and for this purpose had first to determine their relative weights.

Now which is the correct statement of the sequence of events in the earliest days of the atomic theory, namely, in 1803? Is it Thomson's record of what Dalton said in 1804, or Dalton's own lecture notes written in 1810? Roscoe and Harden proved the latter to be correct, from a detailed study of Dalton's laboratory notes. Hence the endeavor to determine atomic weights, the formulation of the chemical atomic theory, was at first a side-issue undertaken to satisfy his curiosity about a much less important question in physics. But nevertheless Dalton was a chemist as well as a physicist—he was well acquainted with Lavoisier's "Traité elementaire de Chemie," in the days when he conceived the atomic theory. His early acquaintance with science was, however, on the physical side, as is indicated by the syllabus (Figure 2) of a course of lectures which he gave in the year 1791.

The Earliest Records of Atomic Weights, Atomic Symbols, and the Formulas of "Compound Atoms"

The first known reference to atomic weights occurs, with a list of symbols to represent atoms of the elements and "compound atoms," on pp. 244,

248, 249 of Dalton's note-book, no. 1. For their historical interest these pages are reproduced in Figure 3.

It will strike the reader that Dalton's figures are far from those now accepted. The reasons are two-fold: first, that no high accuracy in analysis had been attained at the time; second, that Dalton had to make assumptions as to the numbers of atoms which combined together. For example, the gravimetric composition of water, according to the best analyses available in 1803, was: H = 15 per cent, O = 85 per cent. Then, since only one compound of hydrogen and oxygen was known, it was quite reasonable

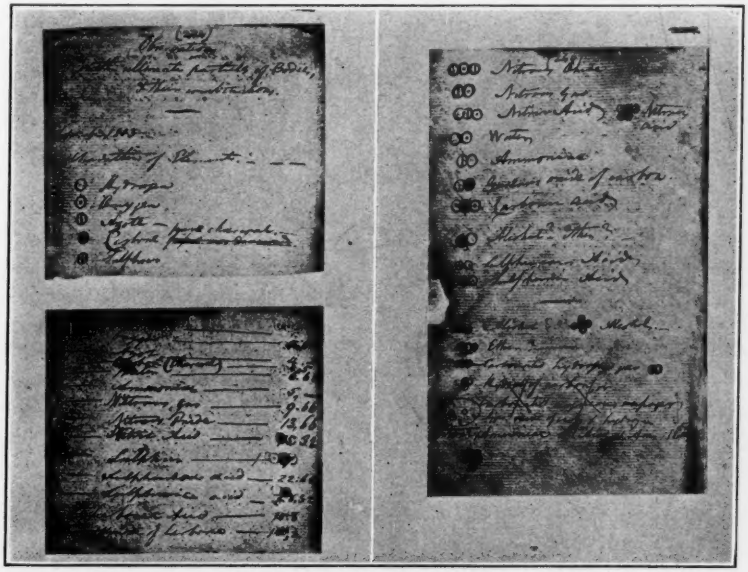


FIGURE 3

to assume that, for want of evidence to the contrary, the "compound atom" of water contained one atom each of hydrogen and oxygen. Hence the relative atomic weights were in the ratio of 15 to 85, or 1 to 5.66. By the year 1806 a less inaccurate analysis was available, and this gave a ratio of 1 to 7, which is nearer to the ratio of the equivalent weights now recognized.

In the year 1805 appeared Dalton's first published list of the weights of simple and compound atoms, some 21 in number, in a *Memoir* of the Manchester Literary and Philosophical Society. At the end of a paper entitled, "On the Absorption of Gases by Water and Other Liquids" (read on Oct. 21, 1803), appears the statement:

Why does water not admit its bulk of every kind of gas alike? I am nearly persuaded that the circumstance depends upon the weight and number of the ultimate particles of the several gases; those whose particles are lightest and single being least absorbable, and the others more, according as they increase in weight and complexity. An enquiry into the relative weights of the ultimate particles of bodies is a subject, as far as I know, entirely new; I have lately been prosecuting this enquiry with remarkable success. The principle cannot be entered upon in this paper; but I shall subjoin the results, as far as they appear to be ascertained by my experiments.

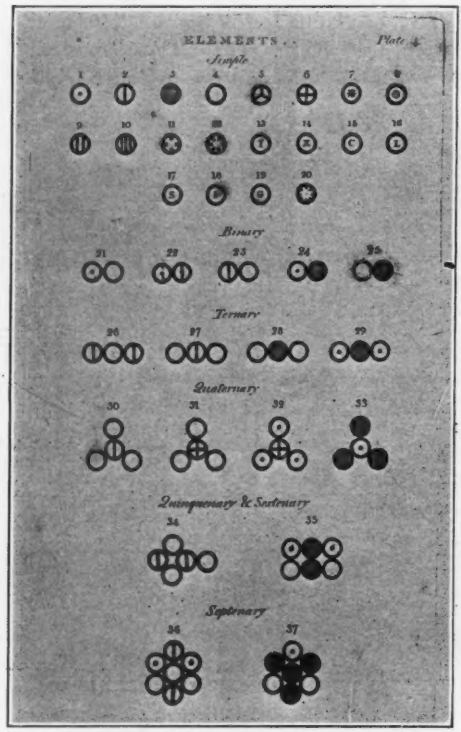


FIGURE 4

Table of the Relative Weights of the Ultimate Particles of Gaseous and Other Bodies

Hydrogen	1
Azot	4.2
Carbone	4.3
Ammonia	5.2

(There were 17 other items.)

Three years later, in 1808, appeared Dalton's first published statement of the principles which guided him in determining the numbers of atoms present in any one "compound atom" (molecule) ("New System of Chemical Philosophy," vol. 1, part 1, pp. 211–220). The results are shown in Figure 4, the key to which (with the weights of the simple and compound atoms, deduced from gravimetric analyses) is:

SIMPLE ATOMS

1.	Hydrogen	1
2.	Azote (nitrogen)	5
3.	Carbone	5
4.	Oxygen	7
5.	Phosphorus	9
6.	Sulphur	13
7.	Magnesia	20
8.	Lime	23
9.	Soda	28
10.	Potash	42
11.	Strontites	46
12.	Barytes	68
13.	Iron	38
14.	Zinc	56
15.	Copper	56
16.	Lead	95
17.	Silver	100
18.	Platina	100
19.	Gold	140
20.	Mercury	167

COMPOUND ATOMS

21.	Water	8	30.	Oxynitric acid	26
22.	Ammonia	6	31.	Sulphuric acid	34
23.	Nitrous gas (nitric oxide)	12	32.	Sulphuretted hydrogen	16
24.	Olefiant gas (ethylene)	6	33.	Alcohol	16
25.	Carbonic oxide	12	34.	Nitrous acid	31
26.	Nitrous oxide	17	35.	Acetous acid (acetic acid)	26
27.	Nitric acid	19	36.	Nitrate of ammonia	33
28.	Carbonic acid	19	37.	Sugar	35
29.	Carburetted hydrogen (methane)	7			

The Lecture Diagrams

About 12 years ago there was discovered in a cupboard in the old house of the Manchester Literary and Philosophical Society a set of ancient looking diagrams which proved to be those used by Dalton to illustrate his lectures in chemistry and physics. There are 150 of these, all apparently prepared by his own hands. Some of them illustrate Dalton's ideas of the chemical constitution of substances, and his exposition of the atomic theory, in a way that could hardly be suspected from any of his publications or from his biographers' writings. They had lain forgotten during many decades. All of them have been described in detail;[1] photographs of the most interesting of them are reproduced herewith. (Figure 5, "Elements.") This is probably the second list of atomic weights presented publicly, the first being that referred to previously. There can be little doubt that it was prepared in 1806 or 1807 for illustrating the lectures delivered in Scotland in April of the latter year.

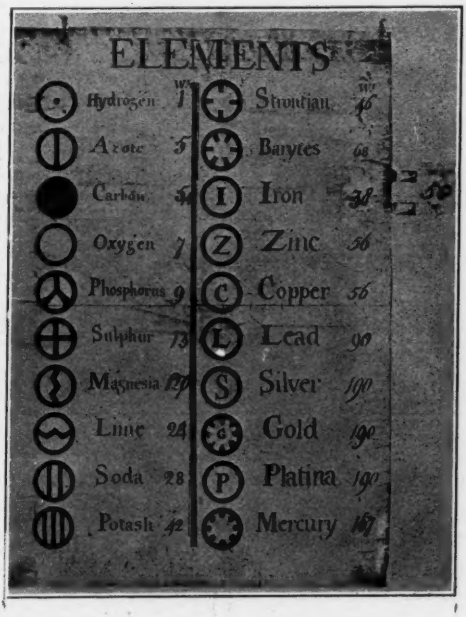


FIGURE 5

[1] Gee, Coward, and Harden, *Mem. Manchester Lit. Phil. Soc.*, **59**, Mem. 12 (1914–15).

The date of the plate has been fixed by a comparison between the figures on it and those in the note-books and printed records. Many of the figures had been revised at one time or another. Thus, the figure for iron was, first, 40, then was altered to 38, and afterwards a slip of paper bearing the figure 50 was pasted over the others. "Magnesia" (regarded as an element at that period) was originally 20, thereafter was covered with a slip bearing the Figure 17; some time later the slip became detached, but the ink stain from the superposed slip is visible.

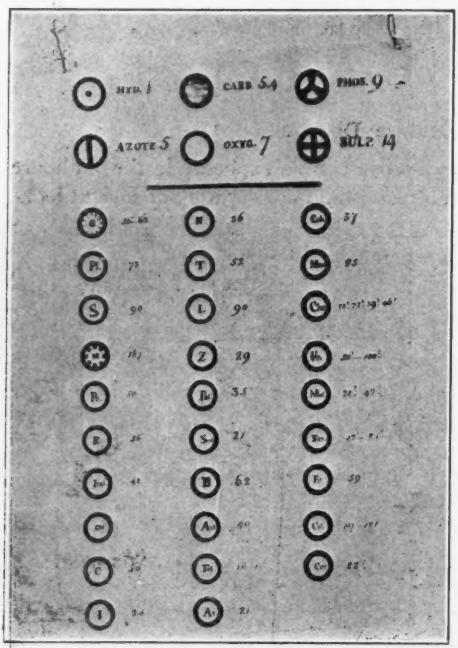


FIGURE 6

The sheet of atomic symbols and weights reproduced in Figure 6 is evidently much later than the previous one and is not very different from the corresponding list of Elements in Volume II of the "New System," dated 1827.

Sheet 5, "Atoms of Elastic Fluids," is reproduced in Figure 7. The "atoms" are represented as surrounded by atmospheres of heat of different sizes. They express Dalton's conception, during the period 1806 to 1809, of the composition and size of the atom of: (1) hydrogen, (2) hydrogen sulfide, (3) nitrous oxide, (4) carbon dioxide, (5) water, (6) hydrochloric acid ("muriatic acid"), (7) methane ("carburetted hydrogen from stagnant water"), (8) carbon monoxide, (9) nitric oxide ("nitrous gas"), (10) ammonia, (11) nitric acid, (12) alcohol, (13) oxygen, (14) nitrogen, (15) ether, (16) ethylene ("olefiant gas").

It illustrates the state of knowledge, or ignorance, at the time, that the composition of muriatic acid was represented by the equivalent of HO_3; and that methane, ethylene, ether, and alcohol are, respectively, CH_2, CH, C_2H, C_3H.

Sheet 3 (Figure 8) shows alternative formulas for (*a*) water, (*b*) ammonia. In the Edinburgh and Glasgow lecture notes (1807) Dalton refers to this or a similar diagram immediately after a discussion of the com-

position of water and ammonia: "See small scheme of three modes." In the famous chapter "on chemical synthesis" in the "New System" I, i, 211–216 (1808), is the following rule which led Dalton to choose the binary formulas for these two compounds: "When only one combination of two bodies can be obtained, it must be presumed to be a *binary* one, unless some cause appear to the contrary." No "cause to the contrary" was ever admitted by Dalton for these formulas.

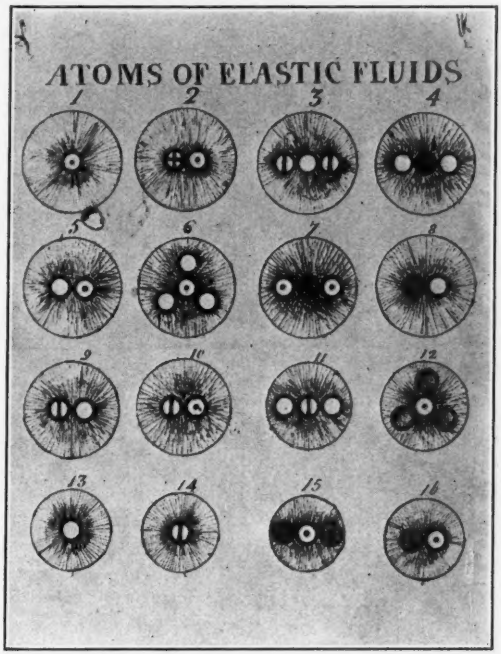


Figure 7

Sheet 4 shows alternative formulas for the two oxides of carbon. Dalton chose the latter two formulas to represent carbon monoxide and dioxide, respectively.

Sheets 6, 7, 9, 10, are probably of earlier date than the older of the atomic weight lists; they seem to have been prepared in 1804 or 1805, and are among the oldest existing records of the chemical atomic theory. On the original sheets can be read, in Dalton's handwriting:

Sheet 6. Nitrous oxide, 13.9.
Sheet 7. Carbonic acid, 15.3.
Sheet 9. Carburetted hydrogen from stag. water, 6.3.
Sheet 11. Ether, 10.4.

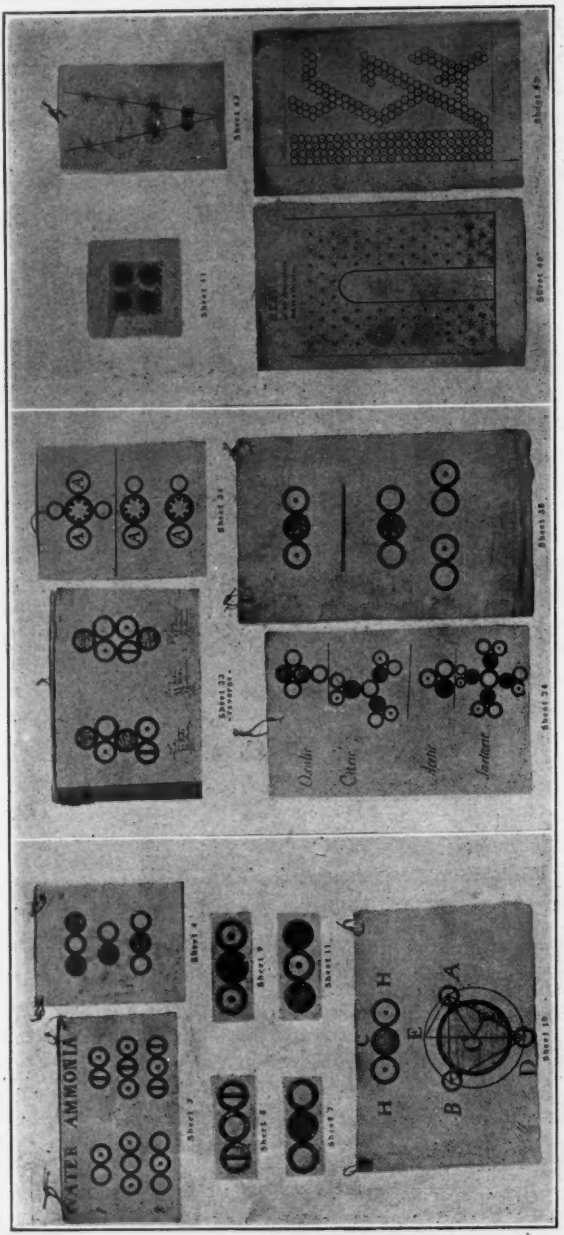


FIGURE 8

Sheet 10 shows the same formula as sheet 9, for methane, together with a diagram apparently representing three atoms of hydrogen round a carbon atom. It has not been discovered what this latter figure was intended to illustrate, but possibly Dalton was attempting to show that a compound CH_3 would be less stable than CH_2 (methane), on account of the greater proximity of the self-repellent atoms of hydrogen in the former.

Sheet 23 (reverse side), shows the atoms C_2, H_2, O, N arranged in two different ways to represent albumen and gelatin, respectively, and under them Dalton has written:

Expt. Albumen	Theory	Expt. Gelatine
53 Carbone	44 Carbone	48 Carbone
27 Water	32 Water	31 Water
20 Ammon.	24 Ammonia	21 Ammon.
100	100	100

Dalton clearly postulated isomerism when writing the formulas for these two compounds. It is interesting to note the little respect he showed for the analytical results, since he is apparently satisfied that there is sufficient accordance between the experimental and the calculated figures.

Sheet 24 and many of the other sheets which are not reproduced here show that Dalton attempted to represent the constitution of many organic compounds; a fact which would not be suspected from his published work. In many of these formulas for organic compounds he placed the atoms C H O in proximity: The note-books show that in 1811 he had the idea of an important part played by this group, which he called the "vegetable atom," with a weight 13.4. With modern atomic weights the group would become CH_2O, which, as formaldehyde, plays an important part in organic synthesis, both in nature and in the laboratory.

Sheet 34 shows the reduction of a mercuric salt to a mercurous salt. Above the line is represented a mercuric salt ("A" designates generically the "atom" of an acid). Below the line are represented two "atoms" of the corresponding mercurous salt formed from the mercuric compound by interaction with an atom of mercury. The sheet was most probably prepared to illustrate the Edinburgh and Glasgow lectures of 1807.

Sheet 35 shows the combustion of methane, which is represented by the formula for methane above the line, and the formulas for one "atom" of carbon dioxide and two of water below the line.

The two diagrams, sheets 34 and 35, are almost chemical equations; it was many years later that chemical equations first made their appearance in text-books.

Sheet 41 shows four atoms with their "atmospheres of heat."

Sheet 43 was designed to show the diminishing repulsion between two atoms with increasing distance.

Sheet 46: "Heat in an atmosphere and in a vacuum." A reference to "heat in a vacuum" is found in Dalton's "New System," **I**, i, 73 (1808): ". . . .interstitial heat amongst the small globular molecules of air, ... (which) scarcely can be said to belong to them, because it is equally found in a vacuum or space devoid of air, as is proved by the increase of temperature upon admitting air into a vacuum."

Sheet 53 represents water (to the left) and ice (to the right), the hydrogen and oxygen atoms being differentiated. The hexagonal form of snow crystals is represented as a consequence of the packing of the atoms. Figure 9 is a reproduction, not of a lecture sheet but of page 372 from Dalton's notebook No. 11, dated March, 1834. This shows tridimensional formulas for oxamide which with the current atomic weights was composed of one atom each of carbon, hydrogen, oxygen, and nitrogen. The two small formulas, considered together, suggest that the idea of stereoisomerism may have been in Dalton's mind at the time he drew them.

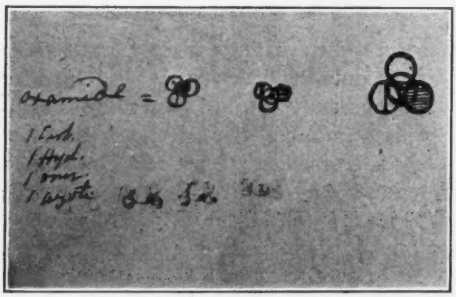


FIGURE 9

It is possible to read more importance than is warranted into the rudimentary ideas of chemical equations, organic radicals, isomerism, and stereoisomerism exhibited on these plates. But although these ideas are not found in Dalton's publications, they were there and who can now say to what extent they may have influenced subsequent developments in chemistry, in view of the fact that Dalton gave innumerable lectures on chemistry in his own country, and paid visits to contemporary chemists in Scotland and in France? Their main interest to me, however, is the fact that they prove that the atomic theory was envisaged by Dalton as an exposition of invisible realities, not merely as a convenient conception of possibilities, and that his attitude led him to make inferences which would surely have been missed if the theory had not been to him a picture of definite physical fact.

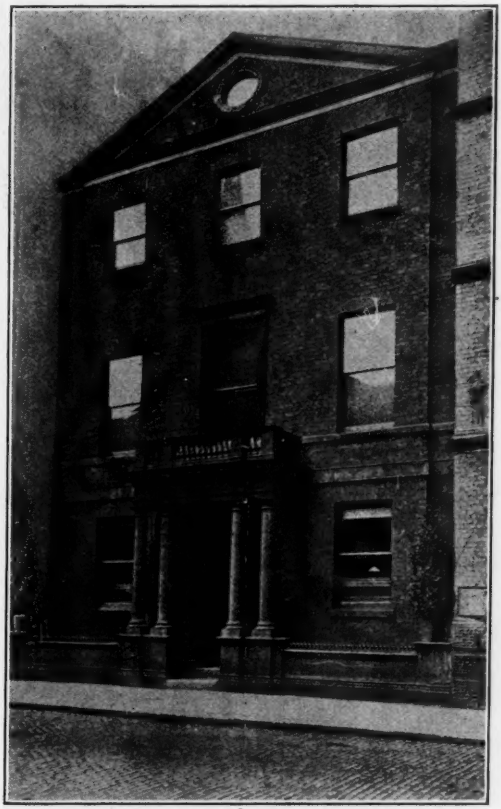
Dalton's Apparatus

Dalton bequeathed "all his chemical and other philosophical instruments and apparatus" to his friend and biographer, W. C. Henry, by whom they were presented to the Literary and Philosophical Society (Manchester, Eng.). They have been described by Francis Jones in the *Memoirs*

of that Society (**48,** no. 22 (1904)). Photographs of some of the more interesting are reproduced here.

Figure 10. Gas measuring apparatus, and a conical vessel containing mercury.

Figure 11. With the exception of the second from the left, this repre-



Literary and Philosophical Society, 36 George Street, Manchester.

sents a set of water thermometers of different materials (stoneware, brass, iron, tin, lead, etc.), for determining the temperature of the maximum density of water.

Figure 12. A glass alembic, a flask, and valve for determining the specific gravity of gases, a spark eudiometer of thick glass, and bottles containing platinum, tin amalgam, bismuth amalgam, iodine, cochineal, mercury,

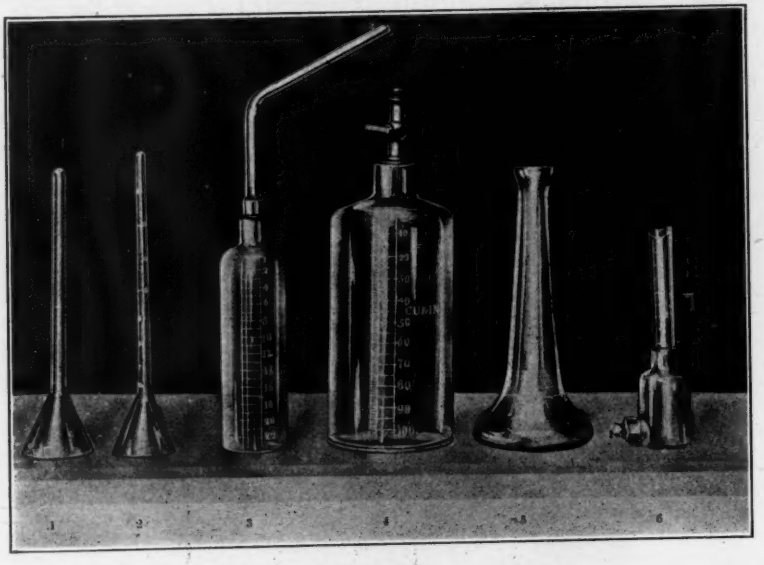


FIGURE 10

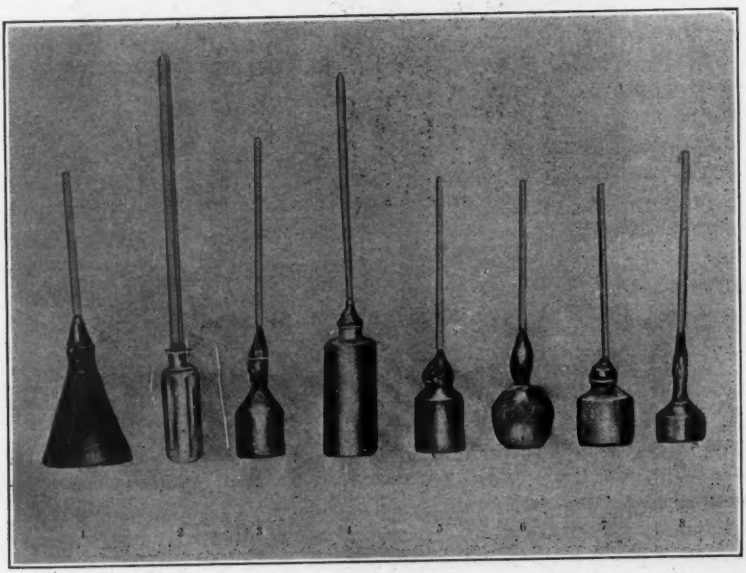


FIGURE 11

gunpowder, mercury, grana sylvestra cochineal, quercitron bark, resin, mercury, madder, lead and mercury, and creosote.

In the old house of the Manchester Literary and Philosophical Society, Dalton had a room and for many years presided over the scientific meetings. The Society has collected and preserved many relics of Dalton; his ap-

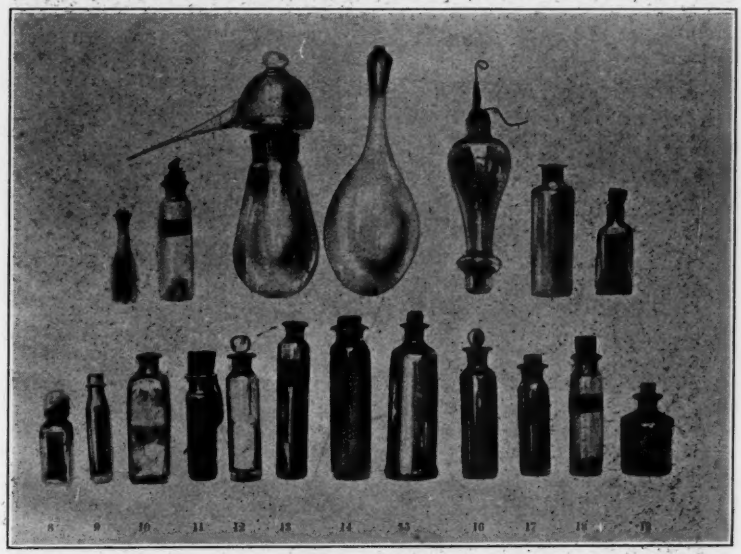


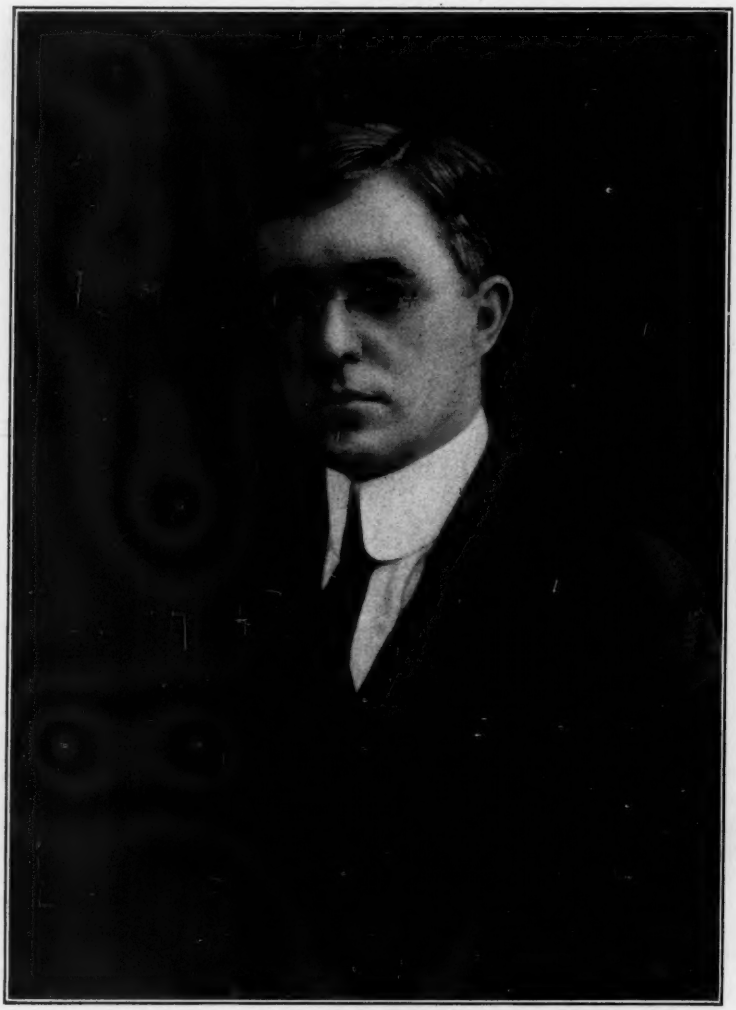
FIGURE 12

paratus for illustrating the principles and phenomena of physics and chemistry, his "hortus siccus" and meteorological records, his account books and some correspondence, as well as a hat and a pair of slippers, a fine portrait, and several busts. May I suggest that many American chemists visiting England would be more interested in spending a short time in 36 George Street, Manchester, than by the conventional visit to Stratford-on-Avon?

Bureau of Standards Celebrates Quarter Century. Twenty-five years ago Congress created a new government bureau which was given charge of the weights, measures, and other standards of the country and charged to conduct research and tests for the benefit of the government and the public. On December 4th the National Bureau of Standards celebrated its arrival at the quarter century mark.

Located on the outskirts of Washington its staff of 800 scientists and assistants occupy twenty-two buildings scattered over an area of 43 acres. Its various laboratories perform 180,000 tests a year and its budget is over $2,000,000 a year.

It is estimated that its researches on all sorts of scientific and industrial problems have resulted in savings of many millions of dollars and dividends on the investments of many thousands per cent.—*Science Service*



Dr. Irving Langmuir, Assistant Director of the Research Laboratory, General Electric Company.

ATOMIC HYDROGEN FLAMES

Guy Bartlett, General Electric Company, Schenectady, N. Y.

When Dr. Irving Langmuir, assistant director of the research laboratory of the General Electric Company, about fifteen years ago, started a series of experiments to determine the effects of different gases in incandescent

Fig. 1.—Welding with the Automatic Hydrogen Arc.

lamp bulbs, he was not thinking of possible future commercial applications of the results. He just wanted to see what would happen; it was a problem in pure research. And, even if he had thought of the possible outcome of those experiments, it is almost certain that he would not have foreseen that, years later, those experiments with traces of gases in incandescent bulbs would lead to the development of a method for producing welds as strong and ductile as the original metals. Such, however, has been the case.

Previous to his work, it had been considered that a vacuum was necessary for efficient operation and long life of lamps, but Dr. Langmuir found that the use of a coiled filament in a lamp containing an inert gas such as argon or nitrogen produced an even more efficient lamp in the larger sizes.

In the course of his experiments on the heat loss of incandescent filaments in a gaseous atmosphere, Dr. Langmuir discovered that the heat loss increased at a constant rate up to the melting point of the tungsten filament, except in the case of hydrogen. This gas behaved like other gases up to a

FIG. 2.—Fan-shaped Hydrogen Arc Flame.

certain temperature, but beyond that the heat loss increased much more rapidly.

Up to slightly more than 1400°C. the heat loss increased with the 1.9th power of the absolute temperature, but above that temperature the rate of heat loss increased considerably. From 2300°C. to 3100°C., for instance, the heat loss, with the gas at atmospheric pressure, increased with the fifth power of the absolute temperature.

The theory was advanced that the abnormal behavior of hydrogen was due to dissociation of the gas into atoms, with the absorption of considerable energy. Thus the hot tungsten filament dissociated the gas, more heat energy was absorbed from the filament, and the energy was liberated in the cooler portion of the bulb when the atoms recombined to the molecular state. Although this theory explained the phenomenon, there

was still the possibility that the action might be due to the temporary formation of molecules containing more than two atoms, but the law of mass action proved that dissociation was the correct explanation.

Continuing the theoretical investigation, Dr. Langmuir found that large quantities of atomic hydrogen were formed in an electric arc between tungsten electrodes by directing a jet of hydrogen from a small tube into the arc. The atomic hydrogen recombines to the molecular form immediately beyond the arc, and in so doing liberates about half again as much heat as does the oxy-hydrogen flame. Molybdenum, one of the most refractory of metals, melts with ease in this flame. Quartz melts less easily, in spite of its lower melting point, indicating that the metal has a catalytic action.

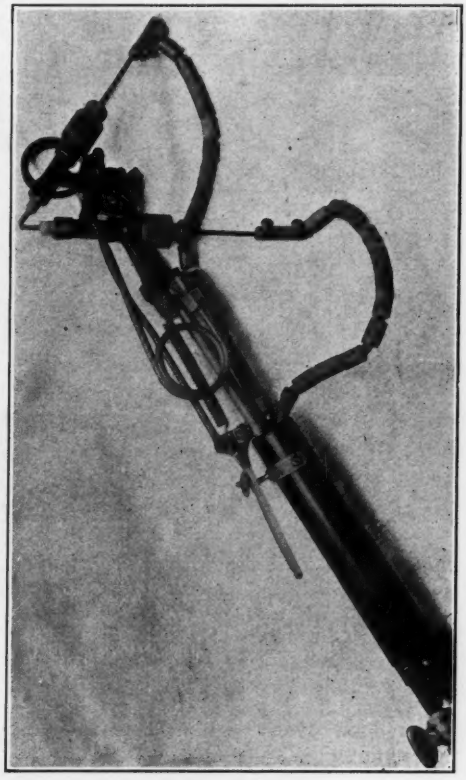


FIG. 3.—Laboratory Design of Hydrogen Arc Welding Torch, Type I.

Iron can be melted or welded in the flame without contamination by carbon, oxygen, or nitrogen. Because of the powerful reducing action of the atomic hydrogen, alloys containing chromium, aluminum, silicon, or manganese can be welded without fluxes and without oxidation. The speed with which iron and similar metals can be melted seems to exceed that in the oxy-acetylene flame.

The two electrodes of the atomic hydrogen torch are tungsten rods held at an acute angle with each other by means of lava insulators. The electrodes are in contact with each other when the equipment is not in use; they can be separated by pressing a lever on the handle. Slow adjustments of the electrodes are made with a set screw. Hydrogen, supplied by a tube through the handle, is used in sufficient quantity so that not only are the electrode tips surrounded by enough of the gas to form

the blast of atomic hydrogen, but by an additional quantity to surround the work with molecular hydrogen. Thus there is a flame within a flame. The atomic hydrogen, in recombining to the molecular form, gives an intensely hot flame which is surrounded by another of hydrogen burning in air. Since hydrogen is a reducing agent of the highest order, the formation of oxides within the flame is, therefore, impossible.

Either alternating or direct current can be used, but alternating current has been found more convenient and electrodes of smaller diameter can be

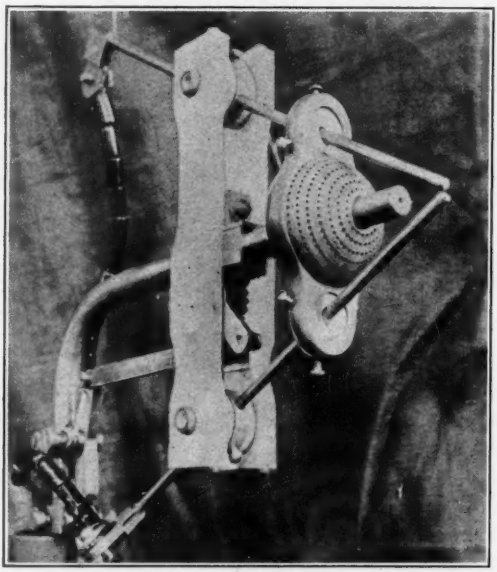


FIG. 4.—Laboratory Design of Hydrogen Arc Welding Torch, Type II.

used. A gas pressure of less than one pound per square inch was sufficient in the laboratory with short lengths of tubing, with metals up to one-half inch in thickness. The rate of gas consumption varies between 20 and 30 cubic feet per hour for ordinary welding. The torch is held close to the metal, and is inclined so that the blast of hydrogen from the torch passes over the molten metal in a direction opposite to that in which the torch is moved.

Low carbon steels up to one-half inch in thickness have been welded without additional material, after being butted together tightly. Considerable work has also been done in connection with fully automatic welding using a butt joint, and with no metal added to the seam. Welds have been made on seamless tubing with a wall thickness of one-quarter inch and

an outside diameter of four inches, and with boiler plate iron an inch thick. Welds on deoxidized copper, such as silicon-copper, have been made up to three-eighths inch thick metal, giving unusually good sections.

Welded portions have been twisted and bent double without cracking or otherwise being injured. Such a procedure has not been possible with the ordinary arc weld, since they are usually brittle due to the presence of nitrides or a thin film of oxide or scale, avoided in the atomic hydrogen flame.

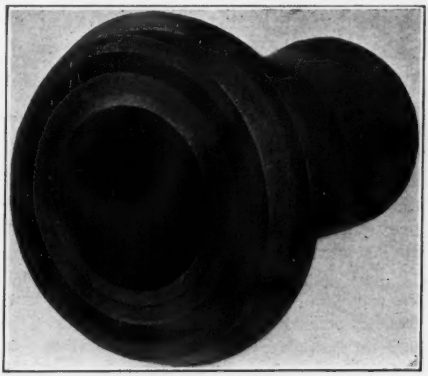


FIG. 5.—Weld of Rectifier Seal, Joining Chromium and Low Carbon Steel.

The technical development of this welding process has been the work of several men in the Schenectady laboratory, including R. A. Weinman and Robert Palmer. They have developed and

FIG. 6.—Welded Joint Subjected to 90-Degree Bend.

experimented with many types of welding torches and with different welding methods. Experiments have also been conducted with several gas mixtures and various electrodes, and the best results have usually been obtained when tungsten electrodes and hydrogen alone are used.

Considerable work has been done with this welding method in the laboratory, but commercial apparatus has not yet been developed.

Flowing Coal Powder Aids Industries. A great increase in the use of pulverized coal by American industries is predicted by H. A. Schaffer, conservation engineer of the Portland Cement Association. Mr. Schaffer bases his statement on the development of a new method of conveying which permits the carrying of powdered coal about the manufacturing plant almost as though it were a liquid.

The use of the easily ignited pulverized coal is not a new thing, but its success in the past has been limited by the rather clumsy machinery for carrying it from the grinding mills to the place of burning, Mr. Schaffer points out. Screw conveyor and elevator systems have been proved more or less inefficient because of the multiplicity of drives required to operate the various sections which are of a limited length.

"By means of the new method powdered coal may be easily introduced into any existing plants where high heats are required," said Mr. Schaffer. "A screw pump equipped with a compressed air shaft forces the coal along the pipe line, which may be curved around the plant at will. Changes in the height of the pipe line do not lessen the efficiency. The internal friction of the pulverized coal amounts to almost nothing since each little grain is enclosed in an envelope of air. Consequently the black powder flows smoothly along for distances even greater than those required by the enormous industries of today."—*Science Service*

Medical Fellowships Are Open to Graduate Students. Thirty-seven research students are devoting themselves to the pursuit of the medical sciences on the material sustenance furnished by National Research Fellowships, according to an announcement just made by the National Research Council.

These fellowships were established to help graduate students of proved ability to complete their training in specialized lines of medical research from funds furnished by joint contributions from the General Education Board and the Rockefeller Foundation. Seventy fellows have already completed their training and most of them have gone to academic positions where they are engaged in medical research and teaching.

Applications for fellowships for the academic year 1927–28 should be filed by March 1st and should be addressed to the Secretary of the Medical Fellowship Board, National Research Council, 21st and B Streets, N. W., Washington, D. C.—*Science Service*

New Poison Kills House Ants. The apartment house dweller who finds himself dispossessed of his costly cubicular domicile by persistent clans of ants should take heart. A poisonous potion of particular deadliness has been concocted at the U. S. Department of Agriculture which spells the end of even the little red kind that feed on arsenic syrup without turning an antenna.

Compounds of thallium, one of the rarer elements, are used in the new "dope" which has been found to be a vicious death dealer to several resistant species of the minute pests, according to C. H. Popenoe, expert in the U. S. Bureau of Entomology. Though thallium is too expensive to be used on a large scale as an insecticide its potential value as an efficient bug killer in apartments and houses is of considerable importance. Householders will await with interest the results of further tests on other insects that are being carried out in the Bureau of Entomology.—*Science Service*

A STUDY OF PUPIL ERRORS IN CHEMISTRY

JULIA C. BENNETT, EAST HIGH SCHOOL, CLEVELAND, OHIO

Part I. The Study Outlined

In the school year of 1924–25, a study was made of the errors occurring in the test papers of 55 pupils in 12B (high-school) chemistry.[1]

Assignments of advance lessons, usually from the text-book, were made daily at the beginning of the recitation period, with suggestions as to preparation, orally presented. During the year, 1925–26, the study of pupil errors was continued, using the same types of questions as in the preceding year. The class numbered 68 pupils of the 12B class. In preparation of lessons, however, this group was given not only text-book assignments but also mimeographed sheets containing questions and suggestions helpful in the preparation of the assignments. Care was taken to grade the mimeographed material so that the pupil could be led, step by step, to master his own difficulties. The difficulties encountered by the class of 1924–25, as shown by their test papers, were taken into account in preparing the mimeographed material. Furthermore, a portion of each advance lesson was prepared in class under the teacher's supervision.

The object of this study was to determine, by means of a comparison of the data collected for the two years, whether by greater definiteness in the assignment of lessons and by careful grading of those portions of the assignment presenting difficulties to pupils, a perceptible improvement in learning would result.

The Terman Group Test of Mental Ability was administered to the first group in September, 1924, and to the second group in September, 1925. The following table records the results of this test.

TABLE I

A COMPARISON OF THE INTELLIGENCE QUOTIENTS OF THE TWO GROUPS

	1924–25	1925–26
Range in I.Q.'s	124–78	122–86
Median I.Q.	112	110
Number of pupils below 97	6	7
Number of pupils above 120	8	3

Inspection of the table shows the two groups fairly well matched as to mental ability, with perhaps a slight difference in favor of the first group.

The test questions submitted to the pupils were of the same types in 1925–26 as in 1924–25. These questions were selected rather for the definiteness of the answers which the teacher could expect than for the suitability of the subject-matter, although all the questions dealt with subject-matter treated in the most commonly used texts.

[1] See THIS JOURNAL, 2, 760–9 (Sept., 1925).

The data collected from both classes were taken entirely from the written work of the pupils.

In order to show more fairly whether there was any advantage gained by the group using the mimeographed sheets, a comparison should be made of the percentage of errors on the *first trial* in a written test, rather than on *all trials* (as in the first year's study).

The questions submitted to pupils in the tests were of six types, as follows:

Type 1. Problems on the volumetric and the gravimetric composition of water.

Type 2. The law of multiple proportions and problems based on it.

Type 3. Problems on gas volumes as affected by pressure and temperature changes.

Type 4. Word equations.

Type 5. Formula equations.

Type 6. Formulas.

Part II. The Data and Their Partial Interpretation

A. Questions of Type 1

A few examples of the questions of Type 1 follow:

1. With how much hydrogen will 19 g. oxygen unite?
2. How much water will be formed?
3. How much hydrogen may be obtained by the decomposition of 20 cu. in. steam?

In the following table are recorded the percentages of wrong answers on questions of Type 1 in the two successive years of this investigation. The questions were submitted to the pupils in each case on the day after the assignment had been given.

TABLE II

A COMPARISON OF PERCENTAGES OF WRONG ANSWERS TO QUESTIONS OF TYPE 1 IN 1924–25 AND IN 1925–26

	1924–25	1925–26	Improvement
Weight, metric	45	12	33 points
Weight, English	35	13	22
Weight of product	59	51	8
Volume, metric	45	6	39
Volume, English	37	0	37
Volume of product	46	4	42
Decomposition, weight	42	24	18
Decomposition, volume	40	3	37

Inspection of the data in this table shows improvement of the second year's group over the first year's on every kind of problem of this type. The least improvement (8 points) was made on problems involving weight

of product. These problems were the most difficult ones of this type for both groups of pupils. The greatest improvement (42 points) was made on problems involving volume of product.

B. Questions of Type 2

A problem of the kind illustrating Type 2 presented to pupils in the test is as follows: A compound of carbon and hydrogen contains 6 weights carbon to 2 weights hydrogen. A second compound contains 12 weights carbon to 2 of hydrogen. Consider a fixed weight of carbon. What, then, is the ratio between the weights of hydrogen?

The following table shows the percentage of incorrect statements of the law of multiple proportions and of incorrect answers to the problems based on the law.

TABLE III

A COMPARISON OF PERCENTAGES OF WRONG ANSWERS TO QUESTIONS OF TYPE 2 IN 1924–25 AND IN 1925–26

	1924–25	1925–26	Improvement
Statement of the law	54	18	36 points
Problems involving the law	49	30	19

The foregoing table indicates a marked improvement in learning on the part of the second year's group. However, even now the topic presents great difficulties to many pupils. The texts in common use give few illustrations of this law and no problems. Better methods the second year have lessened somewhat the pupil's difficulties, but the situation is still far from ideal. In the Appendix, Sheet A shows that the plan during the second year has been to give the pupil assistance in understanding the law by means of a goodly number of problems, graded as to difficulty.

Throughout both years, the point of greatest difficulty has been in understanding the nature of the ratio with which the law deals. The fact needs frequent repetition that the ratio is between different weights of the *same* element.

In view of the fact that this high-school group in 1925 did none too well on the law of multiple proportions and that the group of 1924 did even less well, it is interesting to note the findings of an investigator who has recently studied the overlapping of college and high-school chemistry.[2] University freshmen and high-school seniors (our own seniors, 1924–25, being included) were compared on various items of subject-matter in the chemistry course. The investigator reports that "the college group does not know the law (of multiple proportions) as well as the high-school

[2] Fred C. Mabee, "A Test of Achievement in College Chemistry and Results Obtained by Its Use in Both High-School and College Classes," THIS JOURNAL, 3, 70–6 (Jan., 1926).

group." Evidently, the difficulty is not a local one. We are teaching the law of multiple proportions poorly.

C. Questions of Type 3

Problems like the following were included in this type: A gas measures 6 liters at 21°C. and 780 mm. Find its volume at a temperature of 0°C. and a pressure of 760 mm.

TABLE IV

A COMPARISON OF PERCENTAGES OF ERRORS IN ANSWERS TO QUESTIONS OF TYPE 3

	1924–25	1925–26	Improvement
Temperature factor	22	16	6
Pressure factor	20	12	8

This table shows an improvement, though not a remarkable one, in learning to solve problems of this type. With both groups, the temperature factor appears perhaps to be the slightly more difficult one.

D. Questions of Type 4

Word equations similar to the following were asked for in the tests:

Potassium chlorate ⟶ potassium chloride + oxygen
Sodium + water ⟶ hydrogen + sodium hydroxide

TABLE V

A COMPARISON OF PERCENTAGES OF ERRORS IN ANSWERS TO QUESTIONS OF TYPE 4

Word equations for	1924–25	1925–26	Improvement
Heating potassium chlorate	33	15	18
Action of sodium on water	49	36	13
Heating mercuric oxide	16	3	13
Burning phosphorus	20	2	18
Decomposition of water	2	9	−7
Action of steam on hot iron	24	9	15
Action of hydrogen on hot copper oxide	18	21	−3
Action of zinc on sulfuric acid	18	2	16
Action of iron on sulfuric acid	9	7	2
Action of zinc on hydrochloric acid	23	2	21
Action of iron on hydrochloric acid	29	2	27
Action of magnesium on hydrochloric acid	15	9	6
Action of copper on hydrochloric acid	11	24	−13

On three items—word equations for decomposition of water, action of hydrogen on hot copper oxide, and action (or lack of it) between hydrochloric acid and copper, there were poorer results the second year than the first year. The greatest improvement was made on the word equation for the action of hydrochloric acid on iron, and on zinc (27 and 21 points). The average improvement per item on questions of this type was 10 points.

The equation for the action of sodium on water was, both years, the most difficult word equation, the chief difficulty being in learning the name of the product, sodium hydroxide.

E. Questions of Type 5

The questions under Type 5 involved writing formula equations for the same reactions for which word equations had been required in Type 4.

TABLE VI

A COMPARISON OF PERCENTAGES OF WRONG ANSWERS TO QUESTIONS OF TYPE 5

Formula equations for	1924–25	1925–26	Improvement
Heating potassium chlorate	42	23	19
Action of sodium on water	64	28	36
Heating mercuric oxide	58	23	35
Decomposition of water	27	7	20
Action of hydrochloric acid on zinc	62	13	49
Action of copper on nitric acid	49	44	5
Action of mercury on hydrochloric acid	51	2	49
Burning phosphorus		47	
Action of hydrogen on hot copper oxide		7	
Action of zinc on sulfuric acid		2	
Action of iron on sulfuric acid		6	
Action of iron on hydrochloric acid		7	
Action of magnesium on hydrochloric acid		1	

The plan pursued during the second year has yielded fruit in improvement in learning to write equations to the extent of 30 points on an average for every equation. The least improvement was on the equation for the action of copper on moderately dilute nitric acid, 5 points. The fact that this equation could not be written correctly by 49% of the pupils the first year, and by 44% the second year even with improved methods, shows the extreme difficulty that this equation presents to our pupils. The greatest improvement was 49 points on each of the two equations, the action of hydrochloric acid on zinc, and the action (or absence of action) of the same acid on mercury.

F. Questions of Type 6

Forty-five different formulas, the same ones that were required the first year formed the basis of testing on Type 6.

It will be noted that, as a whole, there has been no improvement in formula writing by the second year's class. The following table may, in part at least, account for this state of affairs. In order to present valence and formula writing properly, the writer would like to provide pupils with at least twice as much mimeograph material as was possible the second year.

This mimeograph material must include much drill work. Since it was impossible to get ready the necessary amount of printed material, some of the material was presented orally—with the disappointing results recorded in the table.

TABLE VII

A COMPARISON OF PERCENTAGES OF ERRORS IN ANSWER TO QUESTIONS OF TYPE 6

		1924–25	1925–26	Improvement +	Improvement −			1924–25	1925–26	Improvement +	Improvement −
1	$FePO_4$	66	35	31		24	$Fe(NO_3)_2$	16	26		10
2	ZnS	66	47	19		25	Ag_2S	15	26		11
3	Na_3PO_4	64	43	21		26	$Ca(ClO_4)_2$	15	15	0	
4	Ag_2SO_4	53	25	28		27	Ag_2SO_3	15	19		4
5	$Al(NO_2)_3$	51	16	35		28	$HgCl_2$	15	25		10
6	$K_2C_4H_4O_6$	51	10	41		29	$Fe(NO_2)_3$	14	29		15
7	$(NH_4)_2CO_3$	49	30	19		30	$Mg(C_2H_3O_2)_2$	14	36		22
8	$(NH_4)_2S$	48	34	14		31	$FePO_3$	14	29		15
9	$Zn(NO_3)_2$	38	44		6	32	H_2SO_3	14	18		4
10	$Fe_2(CO_3)_3$	29	30		1	33	$HgClO_3$	14	20		6
11	K_2CO_3	27	16	11		34	$Fe(NO_2)_2$	12	19		7
12	HNO_2	25	25	0		35	$Fe(ClO_2)_3$	12	12	0	
13	$FeCO_3$	25	28		3	36	$NaClO_2$	12	12	0	
14	$Zn(ClO_3)_2$	25	12	13		37	$FeSO_3$	12	25		13
15	$Mg(ClO)_2$	23	23	0		38	$HgSO_4$	12	14		2
16	Cu_2O	21	43		22	39	Fe_2S_3	8	19		11
17	$Al_2(CO_3)_3$	21	25		4	40	$HgNO_2$	8	13		5
18	$Cu_3(PO_4)_2$	21	28		7	41	Hg_2O	8	16		8
19	$FeSO_4$	21	25		4	42	$CuCO_3$	6	14		8
20	Al_2S_3	19	56		37	43	Na_2SO_3	6	16		10
21	$FeCl_2$	19	22		3	44	Ag_2O	6	19		13
22	$Mg(NO_3)_2$	17	43		26	45	$Fe(ClO_3)_2$	2	17		15
23	$Al_2(SO_4)_3$	17	7	10							

The kinds of formulas which proved most difficult the first year were emphasized the second year. It will be seen that this emphasis bore good fruit, in the results for the first eight formulas. However, the gain in accuracy in writing these formulas was offset by a loss in accuracy in writing the remaining ones.

This phase of the study indicates that, intrinsically, there is, perhaps, no more difficulty in learning to write the formula for ferric phosphate than for ferrous chlorate—this is apparently a matter of emphasis.

In favor of the second year's class, be it noted that the highest percentage of error on any formula is 56, and the next 47; while the highest percentage of errors in the first year's class was 66 in each of two formulas.

It must be admitted that the conditions in 1925–26 were no less favorable

to formula writing than in 1924–5, although, on the whole, the pupils in the latter class wrote formulas slightly better than in the former.

Part III. Further Interpretations of the Data

A

TABLE VIII

SHOWING THE NUMBER OF PUPILS MAKING A PERFECT SCORE ON EVERY QUESTION

Questions on	1924–25	1925–26
Composition of water	7	7
Law of multiple proportions	10	19
Gas volumes	9	37
Word equations	8	6
Formula equations	7	8
Formulas	0	2

In each of the tables in Part II, only one answer by each pupil on each question was taken into account, in order to show us how much of the lesson he could master by using the mimeograph sheet. However, many of the questions on which poor responses were obtained on first trial were repeated after further explanation of difficult points. For example, in 1925–26, the pupils wrote 30 formula equations: 8 pupils of the 68 wrote every equation correctly, while the reluctant or less capable 60 were endeavoring to achieve what measure of success was possible in their sundry cases.

Consideration of the figures here presented leads one to a realization of the need for a course in chemistry in which some recognition is given to individual differences.

B. Consideration of the Difficulty of Word Equations Compared with Formula Equations

Bringing together the data in Tables V and VI permits some interesting observations.

It is noticeable that in 1924–25, the formula equations are, without exception, more difficult than the word equations. In 1925–26, the word equation was emphasized as a preparation for learning to write formula equations. It is perhaps possible that the improvement in formula-equation writing in 1926 may be, in part at least, due to that emphasis. (The difference in difficulty of word equations and formula equations for the first year ranged from 9 to 42, while the range of difference for the second year was from 2 to 20.) Does not the evidence here presented warrant greater emphasis and drill on word equations before teaching formula equations? We have hardly begun to utilize the word equation as an aid in writing formula equations.

TABLE IX

A COMPARISON OF THE DIFFICULTY OF WORD EQUATIONS AND FORMULA EQUATIONS, BASED ON PERCENTAGE OF INCORRECT RESPONSES

	1924–25			1925–26		
Equations for	Word	Formula	Difference	Word	Formula	Difference
Heating potassium chlorate	33	42	9	15	23	8
Heating mercuric oxide	16	58	42	3	23	20
Action of sodium on water	49	64	15	36	28	− 8
Decomposition of water	2	27	25	9	7	− 2
Action of zinc on hydrochloric acid	23	62	39	2	13	11
Action of zinc on sulfuric acid	18	..		2	2	
Action of iron on sulfuric acid	9	..		7	6	
Action of iron on hydrochloric acid	29	..		2	7	
Action of magnesium on hydrochloric acid	15	..		0	1	
Burning phosphorus	20	..		2	47	
Action of hydrogen on hot copper oxide	18	..		21	7	
Action of steam on hot iron	24	..		9	60	
Action of hydrochloric acid on mercury	..	51		..	2	
Action of nitric acid on copper	..	49		..	44	
Action of hydrochloric acid on copper	11	..		24		

C. Mean Improvement on Types of Questions

TABLE X

SHOWING THE AMOUNT OF IMPROVEMENT ON THE VARIOUS TYPES OF QUESTIONS, IN 1925–26

		Average percentage of errors		
	Types of questions	1924–25	1925–26	Improvement
1	Composition of water	44	14	30 points
2	Law of multiple proportions	51	24	27
3	Gas volumes	21	14	7
4	Word equations	21	11	10
5	Formula equations	50	16	34
6	Formulas	23	24+	−1+

This table shows an appreciable improvement in learning all the various types of subject-matter except one. It would seem, therefore, that the experiment of giving more definite assignments as described in outlining this study yields a measure of success quite sufficient to encourage a teacher to repeat the experiment, correcting the mistakes and perfecting the details in the light of this year's experience.

D. Conclusion

This study can lead to only one conclusion: that a definite assignment consisting of carefully graded questions on text-book material in which

special attention is directed to items known to be difficult and of suggestions leading a pupil on through a lesson, making it possible for him to overcome his own difficulties, gives much greater mastery of subject-matter than the ordinary assignment with verbal explanations and suggestions.

Only a beginning has been made by the writer in preparing adequate mimeographed assignment sheets. Much more careful grading of questions and of suggestions there must be. The difficulties experienced by the pupils of 1925–26 in learning from these sheets should help in improving the material for the following year.

Possibly the chemistry of the future will be taught in units. Each unit will perhaps be a little pamphlet, wordy, yes, with no apologies for its wordiness. Altogether too long have we given the immature pupil condensed subject-matter. It may be necessary to present the various units of subject-matter in pamphlet form for few texts can be large enough to allow for all the wordiness that the case demands.

Part IV. What Other Studies Show as to Success in Chemistry Teaching

A. Introduction

A chemistry teacher noting the foregoing data will perhaps conclude that his own pupils could make a far better showing than that made here. Perhaps so: but until that teacher has actually obtained his data from the written work of his pupils on as objective testing material as that used in this study, his conclusions are not convincing. The writer has many times been deluded into thinking that chemistry pupils in an ordinary recitation were completely mastering certain portions, when a written test exposed the fact that only a few pupils had mastered the material completely, many only a part, and a few not at all. Short written tests given to pupils almost daily have shattered any illusions the writer may have cherished regarding mastery of even one day's assignment of the average kind of subject-matter, by 100% of the pupils. But, say you, perhaps the state of affairs in this school is exceptional; perhaps the average high school is doing better than this. As to this point, here are some facts to be reckoned with. In the Powers' General Chemistry Test given to almost 1500 boys and girls in June, 1925, these same pupils who furnished the data for this study obtained a median grade of 49, the school second in rank having a median of 44, and the whole group having a median of 31.5. The Powers' median, based on about 2800 scores, is 36. Also, the 1926 group of pupils represented in this study has a median of 47 on the Powers' test. Other comparative tests have been made, so that the writer is justified in maintaining that at least no poorer work is done by these pupils than is done in the average high-school chemistry class.

B. The Preparation of Students Who Take the Chemistry Examinations of the College Entrance Examination Board

How well is the task of teaching chemistry done for those pupils who take the chemistry examination of the College Entrance Examination Board? The Twenty-Fifth Annual Report of the Secretary of the College Entrance Examination Board throws some light on this question.

From data on pages 2 and 3 of this report, we compile the following table concerning chemistry examination papers:

TABLE XI

	Number of answer books	Percentage of books rated below 60	Rank of chemistry rating among 9 subjects
1901 to 1905	1156	41	4th
1906 to 1910	1896	36.2	1st
1911 to 1915	2529	42.4	3rd
1916 to 1920	6737	51.1	7th
1921 to 1925	11722	34.3	3rd

Inspection of the data shown here does not impress one with the idea that the chemistry teaching for the C. E. E. B. examinations has been done especially or even reasonably well.

But how about the private schools which prepare boys and girls for college? From data on pages 12 and 15 of the Twenty-Fifth Annual Report, we calculate the ratio between public school pupils and private school pupils taking the C. E. E. B. examinations in chemistry in 1925 to be approximately 1:1.6. Perhaps the private schools which are preparing more than 50% of the candidates taking chemistry examinations for college entrance are doing their task better than the public schools are doing it. Let us examine the following table compiled from data for 1925, from pages 12 and 15 of the Twenty-Fifth Annual Report.

TABLE XII

REPORT ON CHEMISTRY PAPERS IN C. E. E. B. EXAMINATIONS FOR 1925

	Number of pupils	School	Percentage below 60	Average number of pupils below 60
Old Plan	659	Public	40.3	
New Plan	271	Public	25.5	
Total	930	Public		36%
Old Plan	1275	Private	27.4	
New Plan	201	Private	18.2	
Total	1476	Private		26%

The figures of this table show that the private school results are appreciably better than the public school results. But if, as in the case of the private schools, more than one-fourth of the candidates stand below 60 in the entrance examination in chemistry, rather than to say that the

private schools are doing appreciably better work than the public schools in this particular, ought we not rather say that the public school does even more poorly than does the private school?

C. Dr. Gerry's Study[3]

Dr. Henry L. Gerry (Harvard) made a study of the chemistry situation by means of a test of 25 items based on questions in the chemistry examinations of the College Entrance Examination Board. The questions were submitted to more than 1000 pupils. On p. 25 of Dr. Gerry's report, "A Test of High-School Chemistry," we read that the median number of questions answered correctly was:

For Form A, answered by 1545 pupils, 10.6
For Form B, answered by 1339 pupils, 11.9

D. Dr. Powers' Study[4]

Dr. Powers' investigation was based on a test of 67 items. The content of the texts in most common use in teaching chemistry served as the source of the test items selected for the study. Dr. Powers found that the median number of questions answered correctly by about 2800 pupils was 36.

Table XIII

A Comparison of Scores on the Gerry Test and on the Powers' Test

Gerry	Form A	Form B	Powers
50% of the pupils score	10.8	11.9	50% of pupils score 36
16% of the pupils score	14.9	16.3	10% of pupils score 55
2.3% of pupils score	19.0	20.7	2% of pupils score 64
Perfect score	25.0	25.0	Perfect score 67

It will be noted that in both the Gerry and the Powers' tests the norms are exceedingly low, the median pupil in each case answering correctly only about one-half of the questions. As measurements of the results of chemistry teaching, these studies indicate a deplorable state of affairs.

Dr. Gerry says (page 82, "A Test of High-School Chemistry") that the purpose of his test is "to give a comparative measure of the results of teaching the kind of chemistry that is being taught, on the average, in the American secondary school." According to Dr. Gerry's findings, we have little reason to be proud of the kind of chemistry that we teach!

According to Dr. Powers' study (page 40, "A Diagnostic Study of the Subject-Matter of High-School Chemistry"), "The task set for high-school

[3] "A Test of High-School Chemistry," by H. L. Gerry. *Harvard Bulletins in Education*, No. IX, September, 1924. Published by Harvard University, Cambridge, Mass.

[4] "A Diagnostic Study of the Subject-Matter of High-School Chemistry," by S. R. Powers, Teachers' College, Columbia University Contributions to Education, No. 149. Published by Teachers' College, Columbia University, New York City.

students of chemistry is beyond their accomplishment. Evidence is convincing that students obtain no mastery of a large amount of the materials of instruction." And again (on page 48), "A large proportion of the text-book material means little or nothing to 50 per cent or more of the students who have studied one of these texts in high school for one year."

In the face of all the evidence presented, one would be indeed an optimist to feel satisfaction as to the results of chemistry teaching in secondary schools.

Our great need in the field of chemistry teaching is investigation leading to evaluation of subject-matter and of methods of presentation of subject-matter, so that we may, by scientific selection of the content of our chemistry course and by the improvement of teaching technic, achieve more worthy results than are our reward at present.

APPENDIX

Sheet A (Used in Connection with Type 2)

1. If in one compound, 1 weight of hydrogen unites with 8 weights of oxygen, and in a second compound 1 weight of hydrogen unites with 16 weights of oxygen, the weights of oxygen uniting with 1 weight of hydrogen are —— and ——. These numbers expressed in a ratio of small, whole numbers will read ——: ——.

2. Carbon and hydrogen form many compounds. In one, 12 weights carbon are combined with 4 weights hydrogen. In another compound 12 weights carbon are combined with 3 weights hydrogen. What is the ratio between the different weights of hydrogen uniting with the same weight (12) of carbon?

3. Sulfur and oxygen unite to form two compounds. In one, 2 weights oxygen unite with 2 weights sulfur. In the other, 3 weights oxygen unite with 2 weights sulfur. Consider the weights of sulfur in the two compounds. What number represents the weight of sulfur? State the ratio between the different weights of oxygen uniting with that fixed weight of sulfur.

4. Carbon and hydrogen may unite in the ratio of 3:1 by weight.
   Express this fact by a ratio in which the first term is 12.
   Express this fact by a ratio in which the second term is 12.

5. Carbon and oxygen form two different compounds. One contains 12 weights carbon and 32 weights oxygen, while the other contains 12 weights carbon and 16 weights oxygen. If we consider a fixed weight of carbon as ——, then the weights of oxygen uniting with it, —— and ——, are in the ratio of the small, whole numbers, ——: ——.

6. Let us consider some other compounds of carbon and hydrogen.

In one, the ratio of carbon to hydrogen by weight is 3:1. In the other, the ratio is 12:3. Take the fixed weight of carbon to be 12. Then the ratio of the weights of hydrogen uniting with this fixed weight is ——: ——. Note that the terms of this ratio are small, whole numbers.

7. If, in 6, you take the fixed weight to be 1 weight of hydrogen, then the ratio of the weights of carbon combining with this fixed weight is ——: ——.

8. Let us consider two other compounds of carbon and hydrogen. In one, the weight of carbon is to the weight of hydrogen as 4:1. In the other, as 10:2. Consider a fixed weight of —— as ——: then the ratio of the weights of —— uniting with this fixed weight, ——: ——, is a ratio between small, whole numbers.

9. Sodium and oxygen form two compounds. Eleven and one-half weights of sodium in the first are united with 4 weights of oxygen. Twenty-three weights of sodium in the second are united with 16 weights of oxygen. Take —— weights of sodium as the fixed weight. Then the ratio of the weights of oxygen uniting with this fixed weight is ——: ——.

10. In one compound there is 75% carbon and 25% hydrogen. (Then the ratio of carbon to hydrogen, by weight, is in small numbers, ——: ——.) In another compound, we have 80% carbon and 20% hydrogen. (This ratio in small integers is ——: ——.) Consider a fixed weight of carbon as ——; then the ratio between the weights of hydrogen is ——: ——.

11. In all the foregoing cases have the results stated been ratios between weights of different elements or between different weights of the same element? Illustrate by means of 3.

12. Two elements, *A* and *B*, may unite to form more than one compound. The weights of *A* may be thought of as uniting with a fixed weight of *B*. Then these weights of *A* are always in the ratio of small, whole numbers to each other. What is this statement called? (P. 73.) Compare this statement with that in your text. Learn either this statement or that in your text.

13. In 12, is the ratio between different weights of *B*? Between the same weights of *B*? Between different weights of *A*? Between the same weights of *A*?

14. If carbon and hydrogen are united in the ratio, by weight, 3:1 in one compound, and in a second in the ratio of 4:1, how do these two compounds illustrate the law of multiple proportion?

15. Now, study page 73 in your text.

There is only one road to progress, in education as in other human affairs, and that is: science wielded by love. Without science, love is powerless; without love, science is destructive.—BERTRAND RUSSELL, *Education and the Good Life*

WHAT SORT OF CHEMISTRY SHOULD BE TAUGHT IN THE HIGH SCHOOL?*

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In trying to build up a fundamental background for this symposium, our first question is, "Does an overlapping of high-school and college chemistry actually exist, and if so, to what extent?" Can we get definite facts on the subject and study the question scientifically, or must we go by impressions and hearsay?

Dr. Koos of the University of Minnesota has recently written a book called "The Junior College." In this book he devotes one chapter to the "Overlapping in Chemistry."[1]

The figures which Dr. Koos presents are the results of careful study and they show conclusively that there is considerable overlapping between high-school and college courses and that it is time something definite was done to prevent such inefficient expenditure of effort.

Either the high-school course, the college course, or both, must change. I believe we will agree that it is the duty of the high school to do most of the reorganizing, with the help and sympathy of the colleges. Certainly we will agree that our high-school course has been merely a vest-pocket edition of the college course. If the college was the first on the ground, and it certainly was in chemistry, then it is largely up to the high-school man to find his place.

There are many other reasons why the high-school course should be the one to change. Dr. S. R. Powers,[2] of Columbia University, has pointed out an excellent one—that the pupils are not learning what we try to teach them anyway. Dr. Powers almost proves his point in a rather extended study. He gave objective tests to high-school pupils from New York City to Minneapolis; including several thousand pupils—about ten thousand, I believe he says—and from this study he found pretty well what pupils were getting of the things we teach every day. He concludes that much of the time and energy of both teacher and pupils has been misspent, if results are the criteria of good work.

We may say that his test doesn't cover all that we teach in chemistry. I hope it doesn't. However, it does cover practically everything that can be answered objectively. It certainly deals with the subject-matter that

* This address is from a symposium on the above subject, held by the Section of Teachers of Chemistry of the Alabama Education Association, at Birmingham, Alabama, on March 26, 1926.

[1] A detailed abstract of this chapter is given in THIS JOURNAL, 2, 798–802 (Sept., 1925). In the interests of space economy the editors have eliminated Prof. Jackson's resumé of Dr. Koos' work. The same is true of the work of Dr. Powers, mentioned hereafter.

[2] See THIS JOURNAL, 2, 174–80 (March, 1925).

we find in the text-books and when we remember that Koos shows us that the text-book is usually the course, then we must realize that our high-school chemistry course needs considerable reorganization if we want to give the pupils things that we may hope they will learn and keep. We see that they don't get a great deal of our present-day material, much less keep it.

Too long have high-school men been dominated by college methods of specialization and college requirements. We must get it out of our minds that we are trying to make chemists out of all of our pupils. Furthermore, we must realize that the main objective in our high-school chemistry should not be college preparation. How many of your pupils ever take a day of college chemistry, my fellow-teachers?

While Vice Principal of the Selma High School, the speaker took it upon himself to answer this question with some definite information. The plan adopted for study was this: All pupils who had passed high-school chemistry in the Selma High School over a period of six years, ending with the class of 1924, were listed. Next, the list was checked off with those who had gone to college. It was found that one hundred sixty-two pupils had passed chemistry during the period outlined. Of that one hundred sixty-two, eighty had gone to college. We find that only 49.38 per cent of the pupils who finished high-school chemistry ever went to college at all.

Next a questionnaire was prepared and one for each pupil was sent to the registrar of the college he attended. In brief the questions were: Did John Doe take chemistry at your college? *Yes. No.* If so, did he pass? *Yes. No.* Did he take two years? Pass? Did he major in chemistry? Each blank sent out was returned. The blanks were then summarized.

This study showed that only forty-two pupils out of the original one hundred sixty-two ever took freshman chemistry in college; or 25.93 per cent of all those who had passed high-school chemistry. Only eight ever took as much as two years of college chemistry; or 4.93 per cent of the original number. Three, or 1.85 per cent of the original number, had majored in chemistry.

I do not have the nerve to stand in front of my chemistry classes and tell the pupils they had better learn so and so or they will have a hard time in college chemistry. I do not feel that a 25 per cent truth is worth very much. I can hardly tell the high-school boy to sweat over the structural formulas of organic chemistry in order that he may find organic chemistry easier when he gets to it in college. I must interest myself in the 96 per cent and not the 4 per cent. When I see a mistake of procedure in the laboratory, I do not go and tell a pupil that a chemist would do so and so—no, for according to the percentages above, I realize that I will not teach a chemist oftener than once in five years.

The speaker would not advocate that all the material just mentioned should be done away with, but he does suggest we get a better reason to give the pupils for doing so and so. We realize that just one study of one school does not give us representative figures for the situation as a whole, but, I believe, we can rely on the direction of the path pointed out by the study. We have seen enough to convince the high-school chemistry teacher that his job is not preparing pupils for college to the degree indicated by the proportion of time that has been spent that way in the past.

So far I have said nothing about the large number of pupils who have started high-school chemistry and dropped by the wayside. Many of these folks probably dropped out because they realized that they would never enter college and, because the instructor held college requirements and entrance examinations, and the type of course that goes along with such, before them day in and day out. They decided that the high-school chemistry class was no place for them. These pupils were failing because the course they were taking was vital only to college preparatory students. Of course, the colleges are not concerned with such a problem as the one just mentioned, but that is all the more reason why the high-school course be different from the college course, for the high-school man has much with which he must concern himself that the college professor need not worry about, just as the college teacher has problems that are peculiar to him.

So far, we have been largely destructive. Let us see if we can give some constructive suggestions. In the first place, we feel that the high-school chemistry course should be an inclusive unit within itself and not be dependent upon being capped off at some future period with a college course. The course should be so arranged that the pupil will have been given valuable training, viewpoints, and information when he finishes, whether he ever goes to college or not. Furthermore, the course should be so valuable that the pupil who does go to college will have had in high school a course that will never be repeated in college, and he can feel that he has something that no college course will ever give him, just as the college course offers something that the high school should never try to give.

Next, it seems that the high-school course should be started from an entirely different point of view from that of the college. Instead of starting a course with a few elements the pupil has never heard of, it seems better to start with some of the few thousand familiar things with which the pupil has had some *conscious* contact. A study of water or burning or something of that kind might make an opening that would catch the pupils from the very beginning. We must develop our high-school course psychologically rather than logically. Through electricity, scientists have shown that they can work wonders with something of which they know little. Why can't a pupil find out a good deal about a compound and what

it does without going into the elementary structure right at once? Photography, picture-show films and such titles at the heads of chapters will probably cause much more interest than silver and its compounds, cellulose nitrates, etc. It isn't always the smallest unit that is easiest to learn. Practically every high-school pupil has a good conception of an inch while he knows nothing of a *mu mu*, yet the inch is hundreds of times larger than the *mu mu*.

In college the man should have some idea of the good he will ultimately receive from a well-developed and logically given course. He may have will-power to wade through the gas laws with their problems without worrying about the common stuff we call water. Not so with the high-school pupil. In these days of double shifts in the city high schools, with little time to study in school, with hundreds of pleasures competing with the school for the pupil's time, and with parents even enticing pupils to pleasure rather than study, we high-school teachers must utilize every method possible to get our pupils enthusiastic over and fascinated with the study of chemistry instead of deadening any innate interest during the first three months and then trying to bring the dead back to life again.

High-school chemistry should not include all laws and theories but should give only those that are actual tools to the study of an appreciation course. With utility in appreciation as our criterion, many of our hobbies would fall by the wayside. I believe a pupil could go pretty far in chemistry without having his way blocked because he did not know the law of multiple proportions. In fact, a Ph.D. confided to me once that he had never reached that point. Such was my own experience with my limited training. Why arm a high-school pupil with such a burdensome weapon for which he will probably never have any use? Let the pupil get the things that belong to a *specialist* as he *specializes*. This is especially significant if we keep in mind the point made by Dr. Powers, that probably a very small proportion of the pupils will ever learn this sort of thing anyway with all of our effort and time.

On the other hand, in this day of radio, with its audion tubes and many types of batteries, who will turn out a high-school pupil without at least an appreciation of electrons, atomic structure, and theory of ionization? Even this should be taught psychologically, however. Let the pupil get to the point where his mind is seeking for the answer to the riddle of this remarkable mystery. About all a teacher will have to do then is to guide the pupil to the point where he can find these things explained.

What does the nation need most from our high-school chemistry pupils? I believe our nation would be better off, and surely our chemical industries would be better off, if the high-school pupils should learn little more than the importance of chemistry in our modern civilization. The only way the German nation is superior to ours in the chemical world is, I believe,

that the whole nation appreciates to the extent that it supports its chemical industries and research. We need that appreciation in this country today. Under such conditions we will never again be caught without necessary drugs like salvarsan, dyes for our clothing, potash and nitrates for our farmers, and other necessities, as we were caught during the past war. Not only in time of war, but in the time of peace our research men would be finding substitutes for expensive materials, would be synthesizing many things that we can hardly find today, would be putting our natural resources and waste products to uses that would save and serve us all.

I propose that the high-school chemistry course shall be an intensive appreciation course. Don't pass judgment too quickly on a novel idea. Much will have to be learned in order to appreciate. If all of our high-school chemistry students will leave school with some idea of the magnitude of the service of chemistry to our nation, then I feel that we will prosper as we have never prospered before. When the high-school pupils—the masses—realize that it is possible for the chemist to take a waste material like coal tar, and a disagreeable one at that, and produce from it all the hues of the flowers that made the coal, along with their original fragrance, the healing properties of the roots and herbs, the flavors sought the world over by mankind, the sweetness that makes sugar taste like a washed-out syrup, the power that will actually do deeds that would make Hercules bow down as an humble servant—then, my friends, we have pupils who can to some extent appreciate the word chemistry. They will never know all about how all these things are done—no, never; but they will have a faith and belief that will cause them all their lives "to give unto the chemist the things that belong to chemistry."

How can this appreciation be brought about? I would suggest as wide reading as possible on each topic that is brought up for class discussion. As many contacts as the pupil can make with his everyday surroundings and readings will impress and re-impress him with the importance and utility of this subject. With entertaining books like "Creative Chemistry," "Chemistry in Industry," and others that may easily be had, with magazines each week and month publishing articles that are both instructive and entertaining, with hundreds of industrial concerns publishing and giving away material that is useful in this way, with all of this and a little guidance from the teacher, it should be easy enough for the pupil to understand and appreciate some of the workings of chemistry.

When a pupil finds that most industries are chemically controlled; when he finds out that the chemical industries are housed in huge factories and not in test tubes and that they turn out their products by the hundreds of tons; and when he finds that all of this goes into our everyday life—then will the pupil *appreciate* the fact that the chemist is not a pill pounder but a creator. When this appreciation is built up among the masses that

never get to go to college, then a new day will dawn for the chemist who does finish his education, for the good of each group, the whole nation, and posterity to come.

This appreciation course will be of definite value to the individual. He will have one more contact with the world through which a more abundant life can flow to himself. He can find recreation in reading intelligently a wider variety of material. His mind has been broadened. He may not know all the details—but he does know that they exist.

What more do most of us know about electricity? Yet see how it serves all mankind. Not long ago a pupil who had a "thorough course" in the college preparatory type of high-school chemistry told me that the only thing he remembered about chemistry was that H_2O stood for sulfuric acid. I am afraid he told the truth. Just think of the inspiration he missed. He was prepared for college, but as he didn't go, he had nothing. Our appreciation course will help to do away with much of the superstition that holds almost every one to some extent—particularly here in the South where we usually explain things according to the adages handed down to us by our negro nurses—yet we are cultured and educated—we admit it ourselves. From an appreciation course we should become more healthy. Although we will not know all about medicine, we will have some idea of the part that chemistry has played in modern medical science and we can appreciate the fact that certain changes will take place with certain chemicals—then we will rely on the physician and not on a dose from our favorite patent-medicine bottle.

Next let us turn to the high-school laboratory. So far, most of our course follows the laboratory manual, as was pointed out at first by the Koos study. The pupils follow their directions as they would follow a recipe book but without the stimulation of knowing that they will have something good to eat when they get through. If a pupil did something a little differently, he would probably be censured by the instructor. In fact, we usually guard our laboratory work so closely that we don't dare allow a pupil to do an experiment before he has studied it in the book for fear he might learn something before he reads about it. If our course is to be an appreciation course, the laboratory can be a great source of help and inspiration. People who see the unfolding of chemical phenomena before their eyes will at least know that it is possible for remarkable things to be done by the specialist along that line. So frequently we ask a pupil why he is doing a certain thing and he will reply, "Because the book said to do it." He is right. He had no other earthly reason for following a few directions. There wasn't anything that he particularly wanted to know. Yet this is what we call "experimenting."

Before leaving the appreciation course, let us see how such a course will fit in with the psychological traits of the adolescent boy with whom

we are dealing. We know children are great hero-worshippers at this time of life. Can we find greater heroes in any other field? The pupils must only be made to feel that the chemists of past ages are real heroes and not stupid folks fooling with ill-smelling substances. Now is the time of life for mystery—turn them loose on the atom of radium. Never are people more curious, and never was there a greater field for curiosity to bring in better results. The laboratory, with a little guidance, is an excellent place to turn curious folks loose in. Of course, the girls must have their thrills. Well, give them some. Chemistry has plenty and to spare. The story of rubber, coal tar, and other subjects can furnish all with romance. The adolescent is changing his outlook on things around him and chemistry will certainly give him plenty of new points of view about everything that he lays his hands on. As the religious instinct develops, the pupil can be made to feel that men like Pasteur served the world almost as faithfully as our Lord himself.

My remarks were to deal with the high-school end of this subject but I may say just a little about the college side as some of our pupils who have the appreciation course must be made to fit into the colleges. Personally, I never worry about college requirements after an appreciation course in chemistry. Did you ever see a pupil appreciate chemistry and not be enthusiastic over it? I have followed the college results of the few who have studied this type of course and so far the results are more satisfactory than with those who studied the other type.

On the other hand, if the college seriously wants to coöperate with the high school, it must make some changes. If the high school is to change its aim, procedure, method, and even subject-matter, it seems that it isn't unfair for the college to alter its entrance requirements to some extent. If the college doesn't want to duplicate the work of the high school, why do we nearly always find in the entrance examination some gas problems, a few laws, a few equations, something about oxygen or hydrogen? If the pupil can pass these then he is put in a class and taught the whole thing all over again. If he doesn't know them to start with he isn't admitted. It seems that the college entrance requirements should be in terms of what the pupil was taught in the high school and not what he is going to be taught in college. As it is I see little need of requirements at all, for the pupils who have had a good high-school course are put right along with those who have had no chemistry.

That brings us to the second suggestion regarding college requirements. It seems that the pupil who has had some high-school chemistry should be given a minimum requirement test, and if he demonstrates ability he should not have to repeat the work with the beginner. The college should inspire good work on the part of both teacher and pupil rather than build up the attitude "well, what is the use—it has to be done all over again,

anyway." Frequently we hear the college professor remark that he wishes his pupils had never had high-school chemistry. A study by Everhart and Ebaugh[3] shows that the pupils who have not had high-school chemistry have only 0.75 time as good a chance to get "A's" in college as those who did have chemistry, while they are 4.5 times as likely to fail as their more fortunate fellows.

I believe that the distinctive type of course outlined for the high school will make the college and high-school courses so different that the matter of requirements will easily be settled. We do believe, though, that the college will have to make some provision for those who have more ability to carry advanced work due to a high-school course.

In conclusion: If the high-school pupil gets only a small percentage of new material when he goes to college, as pointed out by Koos; if the pupils are not going to learn much of the type of material we are now teaching, as pointed out by Powers; and if the majority will never take college chemistry, as pointed out by the speaker's study—then let us do away with the present type of high-school chemistry course and put in its place an appreciation course that will send the *masses* out capable of more abundant life and send the *few* to college realizing that they got much out of their high-school course that will never be given by the college, just as they will get much from the college course which was never attempted by the high-school course.

[3] THIS JOURNAL, 2, 770–4 (Sept., 1925).

Research Betters Electrical Insulation. High-voltage, cable insulation greatly superior to that in commercial use has been developed in the laboratories of the electrical engineering department of Johns Hopkins University, with the coöperation of the Committee on Research on High-Voltage, Cables of the National Electric Light Association. Dean J. B. Whitehead of the School of Electrical Engineering of Johns Hopkins University, Baltimore, has presented to the Association a report of results obtained from experiments extending over many months.

With the increasing use of high voltage, underground cables has come the demand for better insulation to overcome loss of power which has tended to increase at an alarming rate under the high voltages.

It has been thought that the inability of the insulation to stand up under high voltage was due to the breaking down of films of air imprisoned between layers of insulation. Experiments show, according to Dr. Whitehead, that this increasing loss of power is in all probability due rather to loose-fitting sheaths, with air between the insulation and the lead sheath, or to imperfect impregnation of the insulation.

Methods of insulating, impregnating, and sheathing have been worked out on a laboratory scale which give highly satisfactory results up to 30,000 volts. The problem of producing these results by factory methods on a commercial scale remains to be solved.—*Science Service*

THE VITAMINS. III

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Vitamin A ("Fat-Soluble A")

Recently McCollum has republished[1,*] the chart representing the original growth record of an experimental animal (rat) observed by McCollum and Davis and recorded in 1913,[2] which record, he says, "led them to the discovery of the special growth-promoting properties of butterfat as contrasted with vegetable fats and certain animal fats." This work of McCollum and Davis may be considered as constituting the discovery of the existence of vitamin A, or indeed of any fat-soluble vitamin, as we now understand these terms and conceptions. (To what extent the discovery may be considered to have been foreshadowed by earlier workers, is a rather technical question of priority which is outside the scope of this brief and non-technical review.)

Osborne and Mendel, independently and almost simultaneously, made the same observation as had McCollum and Davis upon the special growth-promoting value of butterfat; and very quickly it was shown that egg-yolk fat resembles butterfat in this respect.[3,4]

These observations are of more than historical interest; for the abundance of vitamin A in the fat of milk and of eggs suggests at once its importance as a factor in growth, development, and reproduction.

While vitamin A may not stand in the same direct and all-controlling relation to any one important disease which vitamin B bears to beriberi and vitamin C to scurvy, yet it is probable that, of the three, vitamin A has the greatest total influence upon our health and vitality; and this for a combination of reasons.

Because so many of our staple foods are so poor in this vitamin, a relative shortage of vitamin A is probably of more frequent occurrence, in America and Europe at least, than is a corresponding shortage of vitamin B or C; and when the diet is relatively poor in vitamin A the general health and vitality are lowered and the body becomes more susceptible to infections of several kinds.

In the same year in which it had been discovered that such a fat-soluble substance is essential to growth, Osborne and Mendel reported that animals on diets deficient in this substance become subject to the eye disease which has since been widely discussed in connection with this dietary deficiency under the names of ophthalmia, xerophthalmia, keratomalacia, and conjunctivitis.

Both because this typical eye condition involves infection (apparently by bacteria which are practically always present but which gain the upper hand only when the nutritional supply of vitamin A is inadequate)

* Numbers refer to bibliography at the close of the article.

and because the characteristic susceptibility to this eye disease is accompanied by an increased susceptibility to other infections also, the pathological effects of this dietary deficiency are somewhat less clear cut than are those which result from a lack of vitamin B or of vitamin C.

Since, however, the most significant properties of each vitamin and, in fact, the chief evidence of its existence rest as yet upon the physiological or pathological effects observed to follow the use of diet deficient in the vitamin in question, it seems logical to attempt to summarize here the chief results which have been observed to follow the use of diet deficient in vitamin A. The greater number of these observations have been made upon rats, not as is sometimes supposed because the rat is particularly susceptible to the lack of this vitamin (for as a matter of fact both rabbits and chickens are reported to need relatively more of it than does the rat) but because at the time of the discovery of this vitamin the rat had already become well established as the most practicable laboratory animal for use in research of this kind. There is no reason to doubt, and ample reason to believe, that the omnivorous rat is a good representative of the mammals generally, including man, in his need for vitamin A and in the effects which follow the use of diets which lack it or are too poor in it for the support of optimal nutrition and health.

That results similar to those described below as occurring in the rat are observable also in other animals has been shown experimentally for species varying as widely as the fowl,[6,7] the rabbit[5,8] the dog,[9] and the pig,[10] and there is much clinical evidence showing that the same is true of the human species.[11,12,13,14,15,16,17] According to McCollum:[15] "There are several instances of the occurrence of conditions described in the literature as xerophthalmia, which seem to be beyond question cases in which the disease has occurred in man as the result of specific starvation for the dietary essential, fat-soluble A." The records particularly referred to are those of Mori[11] in Japan, whose cases of xerophthalmia occurring among children at a time of food shortage could be cured by feeding chicken livers (liver usually being rich in vitamin A) and those of Bloch,[13] whose cases among the children of the Danish poor also responded to the feeding of foods rich in vitamin A. Wells[14] found, in Roumania, and Dalyell,[17] in Vienna, cases of children suffering from eye trouble which was cured by cod-liver oil and undoubtedly had been caused by deficiency of vitamin A in their food. The xerophthalmia observed by Bloch[13] among Danish children was doubtless also due to deficiency of vitamin A in the diet since it was cured by feeding whole milk or cod-liver oil; and in 1918 the disease nearly disappeared from the community upon the general introduction, by government action, of butter into the dietary of the poorer people.

When a diet lacking vitamin A, but adequate in other respects, is given

to a young growing rat, growth continues for a longer or shorter time according as the animal has a larger or smaller store of this vitamin in his body at the beginning of such an experiment. After growth ceases the animal may or may not remain at stationary weight for a time, then there usually sets in a loss of weight and a condition of general decline accompanied by increased susceptibility to bacterial infection. This lowered resistance results in a large proportion of the experimental animals developing the characteristic disease of the eye,[4,18] and it has been repeatedly found that diet poor in vitamin A leads to weakness in other respects as well. Osborne and Mendel[18] report diarrhea and diminished appetite as frequently resulting from food poor in this vitamin; and they have definitely correlated this deficiency with the occurrence of phosphatic renal calculi (bladder stones) among their experimental animals.[19] The formation of these bladder stones they attribute to abnormal reaction arising from local infection to which the lining membrane becomes susceptible as the result of the deficiency of vitamin A. McCollum and Davis[2,20] and also Drummond[21] report increased susceptibility to other infections including lung disease among individuals whose diet is poor in this vitamin. Steenbock, Sell, and Buell[22] confirm this and emphasize also the susceptibility to bronchial troubles and abnormalities of the skin.

Pus in the glands near the base of the tongue has also been observed in a large proportion of cases of animals kept upon diets devoid of vitamin A in the writer's laboratory.

Steenbock and his associates[23] have correlated still further the occurrence of respiratory disease with deficiency of fat-soluble vitamin in the food. Futhermore, quantitative investigations at Columbia University have shown[24] that animals whose diet has been relatively poor in vitamin A actually contain less of this vitamin in their lung tissues than do those whose food has furnished the vitamin in more liberal amounts.

Evans and Bishop[25] found that diets containing enough fat-soluble vitamin for growth and protection from eye disease may still require enrichment with this vitamin in order to enable the animal to meet the added demands of reproduction.

Thus there is abundant evidence that a shortage of vitamin A in the food results, sooner or later, in a widespread weakening of the tissues and functions of the body. It seems likely that vitamin A plays the double rôle of a tissue constituent and also of a "regulatory" substance concerned with the maintenance of normal conditions and the control of nutritional processes.

The chemical nature of such an important substance is naturally a problem of very great interest. Drummond, Channon, and Coward[26] have recently reported the results of their own extended research in this field and have at the same time summarized and discussed the findings of

other investigators. They find that vitamin A belongs to the "unsaponifiable matter" of the fats in which it is found, and that it is more readily destroyed by oxidation than is the antirachitic substance ("fat-soluble vitamin D"). They succeeded in distilling vitamin A under nitrogen with reduced pressure and showed, by tests of the vitamin potency of this distillate, that they had effected a very great concentration of the vitamin A; but they do not regard their final product as pure and they conclude that "It has not been possible to decide whether vitamin A is identifiable with one of the unsaturated alcohols" (of the "sterol" group).

While it thus appears that our knowledge of the chemical nature of vitamin A is still but rudimentary, its nutritional importance has led to the development of methods for its quantitative determination by means of carefully controlled feeding experiments with properly prepared standardized laboratory animals (young white rats). The method used in the writer's laboratory was developed largely through the work of Dr. H. E. Munsell and has been described elsewhere.[27] It is based upon the same principle as described in connection with the discussion of the determination of vitamin B in the first paper of the present series, namely, that the experimental animal is given an unrestricted supply of a diet adequate in all other respects but devoid of the vitamin in question, while the material to be tested for this vitamin is fed in graded amounts in order to find just what amount of the material will furnish that precise amount of the vitamin which is needed in order to produce a standard result (in this case a growth of three grams per week, sometimes referred to as "unit growth") in a standard animal.

In the case of vitamin A, two special precautions are of great importance. One is to make sure that a shortage of vitamin D is not mistaken for a shortage of vitamin A as the limiting factor of growth. This can be accomplished by making sure that the experimental animal is provided with vitamin D or its equivalent, in any of four ways: by (1) irradiation of the animal, or (2) of the food, or (3) by adding irradiated cholesterol to the food, or (4) by using such a diet for the families from which the experimental animals are to be drawn that the latter will have stored in their bodies sufficient amounts of vitamin D to meet their needs throughout the vitamin A experiment. In the writer's laboratory such a diet had fortunately been used even in the experiments made before the discovery of vitamin D.

The other special precaution called for in quantitative work upon vitamin A is to be sure that due account is taken of the capacity of the body to store this vitamin so that there shall be no confusion between the vitamin A furnished by the food under investigation and that previously stored in the body of the experimental animal.

Undoubtedly the capacity of the animal body to store relatively large

amounts of vitamin A is of great nutritional importance. Successive studies of this bodily storage of vitamin A under different conditions have been carried on in the writer's laboratory by Dr. Kramer,[28] Dr. Storms,[29] and Dr. Cammack.[30] On account of limitations of space the reader must be referred to the original articles for further discussion of this important point.

Since the storage of vitamin A in the body has been shown to be such an important factor in providing the supply of this substance for future needs, it now seems probable that the supposed lesser need for this vitamin by the adult than by the young is apparent rather than real, and perhaps largely attributable to the fact that the adult has had more opportunity to lay up in his body a store of vitamin A to be drawn upon in case he encounters a period of deficient intake. There is now no doubt that vitamin A plays a very important part in the nutrition of the adult as well as of the young. Experiments carried out by Dr. MacLeod in the writer's laboratory[31] showed strikingly that a proportion of vitamin A in the food sufficient to support normal growth and the maintenance of every appearance of good health, for a long time at least, may yet be insufficient for the best results. In very careful comparative experiments it was found that an intake of vitamin A more liberal than was needed for the support of growth was reflected in greater vitality, longer life, and an increased ability to resist infectious diseases, especially those of the respiratory tract. Hence a liberal intake of vitamin A is important at all ages if a high degree of individual and community health and vitality is to be maintained.

Vitamin A thus becomes a very important factor in food values, and while space does not suffice to enter here upon the discussion of the formation and distribution of vitamin A in nature and its relative abundance in different foods which has been summarized elsewhere,[32] it may be said in conclusion that vitamin A should always be held clearly and prominently in mind in any comprehensive consideration of food values or of nutritive requirements. It is because milk and green vegetables are relatively rich both in vitamin A and in calcium that McCollum has called these the "protective foods" and has strongly and wisely urged their more liberal use in American dietaries.

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[28] H. C. Sherman and H. E. Munsell, "The Quantitative Determination of Vitamin A," *J. Am. Chem. Soc.*, **47**, 1639 (1925).

[28] H. C. Sherman and M. M. Kramer, "Experiments upon Vitamin A," *J. Am. Chem. Soc.*, **46**, 1055 (1924).

[29] H. C. Sherman and L. B. Storms, "The Bodily Store of Vitamin A as Influenced by Age and Other Conditions," *J. Am. Chem. Soc.*, **47**, 1653 (1925).

[30] H. C. Sherman and M. L. Cammack, "A Quantitative Study of the Storage of Vitamin A, " *J. Biol. Chem.*, **68**, 69 (1926).

[31] H. C. Sherman and F. L. MacLeod, "The Relation of Vitamin A to Growth, Reproduction and Longevity," *J. Am. Chem. Soc.*, **47**, 1658 (1925).

[32] H. C. Sherman, "Chemistry of Food and Nutrition," The Macmillan Co., New York, third edition, Ch. XVI, 1926.

Dyes Found Aid to Operations. Will we shortly be riding into the operating room for our appendicitis operation with our tummies painted pink or purple instead of with the commonplace familiar brown of iodine? Medical investigators have decided that the average antiseptics used in hospitals leave much to be desired in germ-killing capacity and after extended research have found that some of the aniline dyes give almost 100 per cent results in obtaining a really sterile skin.

Search for an explanation for the occurrence of occasional cases of septic poisoning in apparently clean wounds has led Drs. Martin B. Tinker and Henry B. Sutton of Ithaca, N. Y., to make a detailed investigation of germicides and antiseptics in current use in some of the best organized hospitals.

"Laboratory studies," say the Ithaca doctors, in a report of their results to the American Medical Association, "have indicated the inefficiency of iodine, the most widely used of the inefficient antiseptics."

"Personal study of more than 1550 cultures, results in most instances confirmed by others, have demonstrated that iodine, trinitrophenol, mercuric chloride solution, mercurochrome-220 soluble, and potassium mercuric iodide will not kill most of the resistant, and some of the less resistant, pathogenic bacteria under conditions of perfect contact, and are still less efficient if penetration is required.

"The aniline dyes seem to deserve further investigation and probably wider use on the basis of apparent germicidal power, penetration, low toxicity, harmlessness to instruments and supplies, and excellent outlining in the field."—*Science Service*

Old Silks Made into New Threads. Turn in your old silk stockings or worn-out clothes of that material and have new silk threads made of them. According to experiments recently carried on by Dr. P. P. von Weimarn of the Imperial Research Institute at Osaka, Japan, this is indeed possible. Dr. von Weimarn states that filaments actually better in quality than natural silk can be produced from worn-out silk materials or from the waste silk from cocoons or factories.

The process, as tried out experimentally by him, is one of partially dissolving the silk in hot, concentrated, aqueous solutions of any of the easily soluble neutral salts and of subsequent partial dehydration. A viscous liquid is produced by the first treatment. This solution is then partially dehydrated at room temperature by the addition of concentrated, aqueous solutions of other easily soluble salts, or of alcohol solutions. The viscous liquid turns to a jelly state and then to a ropy, plastic state in which it may be drawn into threads. A washing process is usually necessary before threads can be drawn which closely resemble the natural silk in quality. Frequently the threads so spun in these experiments possessed even greater tensile strength than the original threads of natural silk. The other qualities of natural silk, such as elasticity, softness, resistance, satin gloss, were present in the threads so obtained.—*Science Service*

THE STRUCTURE OF MATTER: A BRIEF REVIEW OF PRESENT-DAY CONCEPTIONS. IV. THE STRUCTURES OF CRYSTALS

MAURICE L. HUGGINS, STANFORD UNIVERSITY, CALIFORNIA

Solids may be divided into two classes—*crystals*, in which the component atoms or molecules are marshalled in an extremely regular manner, and *amorphous solids*, in which there is no such regularity. The present article deals primarily with the structures of solids of the former class.

The Interaction of X-rays and Crystals

If a crystal is placed in the path of a beam of X-rays,[1] each atom in the crystal—in fact, each electron—will scatter the X-rays in all directions. In general, the scattered X-rays will destructively interfere with each other, but, because of the regularity of the arrangement and the fact that the X-ray wave-lengths are of the same order of magnitude as the distances between atoms in crystals, there will be reinforcement of the scattered rays in certain particular directions (depending on the nature of the structure and the wave-length or wave-lengths present in the X-ray beam).

Crystal structure analysis consists in determining these directions, usually photographically, and deducing therefrom—knowing the wave-lengths of the X-rays—the arrangement of atoms in the crystal. The three general methods of obtaining the necessary data are:

(1) The Laue method, employing a single crystal, set in a fixed position, through which a beam of X-rays containing a whole range of wave-lengths is passed.

(2) The Bragg method, in which the crystal is rotated and the X-rays used consist mainly of a few definite wave-lengths.

(3) The powder method, developed by Hull in this country and Debye and Scherrer in Europe, employing powders, and X-rays containing chiefly one or two wave-lengths.

It has not been found possible to locate directly by means of X-rays the positions of electrons or electron orbits in crystals, but indirectly the distribution of valence electrons can often be, in part at least, determined.[2]

In each of the crystals described hereafter, the general nature of the valence electron distribution the author believes to be practically as definitely known as the arrangement of atomic centers.

Single-Molecule Crystals; Polar and Non-polar Crystals

Each carbon atom in the diamond (Fig. 3) is surrounded by four others at corners of a regular tetrahedron. It is bonded to each by an electron

[1] X-rays, it will be remembered, are of the same nature as visible light, but the wave-lengths are only about one-ten-thousandth as great, that is, about 10^{-8} cm.

[2] Huggins, *Phys. Rev.*, **27**, 286 (1926); *J. Am. Chem. Soc.* **44**, 1841 (1922).

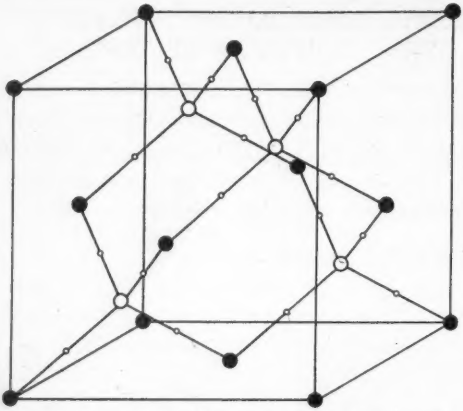


FIG. 3.—Representing the unit cube of the diamond or cubic ZnS. The large dots represent the centers of C or Zn atoms; the large circles C or S centers, and the small circles pairs of valence electrons. In the diamond the electron pairs are midway between adjacent atoms, as shown; in ZnS they are nearer the S centers than the Zn centers.

In the face-centered cubic or "cubic close-packed" structure, atomic centers are distributed as shown by the large dots in this figure.

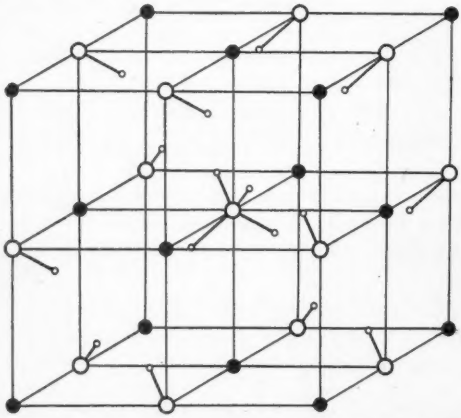


FIG. 4.—The unit cube of NaCl. Large dots represent Na centers, large circles Cl centers, and small circles pairs of valence electrons. The arrangement of large dots *or* of large circles, considered separately, is that of atomic centers in a substance having the face-centered cubic structure.

pair situated midway between the two atomic centers, *i. e.*, by a non-polar single bond. The whole crystal is thus a single molecule.

Silicon, germanium, and gray tin have structures of the same type. The bonds are in each case strictly non-polar, but weaker than in the diamond.

Cubic zinc sulfide crystals are similar (Fig. 3). Each atom is bonded by a semi-polar bond to four of the other kind. The same structure is possessed by AlSb, ZnSe, BeS, HgS, CuCl, CuBr, CuI, and AgI.

The structure of the hexagonal form of zinc sulfide, possessed also by ZnO, AlN, BeO, CdS, CdSe, and AgI, closely resembles that of Figure 3 in the arrangement around each atom.

Sodium chloride possesses the structure of Figure 4. The valence electron pairs are not on the center lines between atoms, but are disposed tetrahedrally around the chlorine kernels. The crystal can then be considered as being built up of Na^+ and Cl^- ions. We have no reason, however, to believe that the forces holding the atoms together are different in nature from those holding the Zn and S atoms together in ZnS, but

in the former crystal they are less localized than in the latter. The other halides of sodium, all those of lithium, potassium, and rubidium,[3] CsF, MgO, MgS, CaO, CaS, CaSe, SrO, SrS, SrSe, BaO, BaS, BaSe, MnO, MnS, CdO, NiO, CoO, PbS, AgCl, and AgBr all have the sodium chloride type of arrangement.

Figure 5 illustrates the cesium chloride type of structure, possessed also by CsBr, CsI, TlCl, TlBr, and TlI. That of CaF_2, BaF_2, SrF_2, CeO_2, ThO_2, and UO_2 is shown in Figure 6.

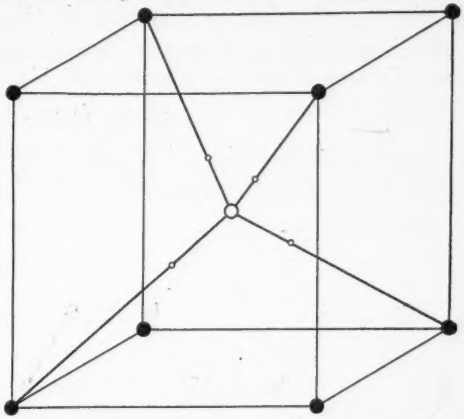


FIG. 5.—The unit cube of CsCl. Large dots denote Cs centers, the large circle a Cl center, and the small circles valence electron pairs. In the metals having the "body-centered cubic" structure, the atoms are all of the same kind, their centers being distributed as shown here by the large dots *and* the large circle.

Layer Molecules

In all of the foregoing the whole crystal must be a single molecule (or, perhaps, in crystals of the CsCl type, two molecules), if we are to speak of a molecule at all in connection with crystals. Some crystals, however, contain what might be called *"layer molecules"*—all the atoms within each layer being held together by definite chemical bonds, while between layers the forces are relatively weak "residual affinities."

In crystals of phosphorus (metallic), arsenic, antimony, or bismuth (Fig. 7), for instance, each atom is bonded by single non-polar bonds to three others, all in the same layer. In mercuric iodide (Fig. 8) each mer-

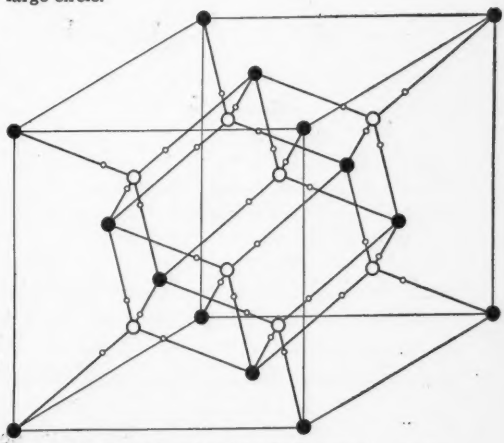


FIG. 6.—The unit cube of the CaF_2 crystal. Large dots denote Ca centers, large circles F centers, and small circles pairs of valence electrons.

[3] Except possibly RbF, for which no unambiguous data are available.

cury atom is bonded to four iodine atoms, all in the same layer, and each iodine to two mercury atoms in the same layer. The structures of CdI_2 and of $Mg(OH)_2$, $Ca(OH)_2$ and $Mn(OH)_2$ (Fig. 9) are similar in that only atoms in the same layer are bonded together. In all these cases the crystals cleave readily between the layers.

String Molecules

A crystal of selenium or tellurium (Fig. 10) contains spirals of atoms extending completely through the crystal from one end to the other, each

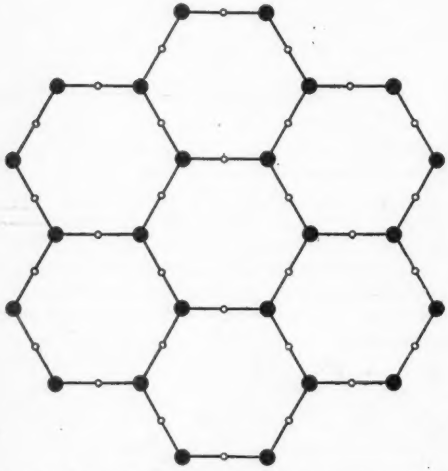


FIG. 7*A*.—Illustrating the arrangement within a "layer" of a crystal of P, As, Sb, or Bi. Large circles denote atomic centers, small circles valence electron pairs. Each atomic center is tetrahedrally surrounded by four valence pairs.

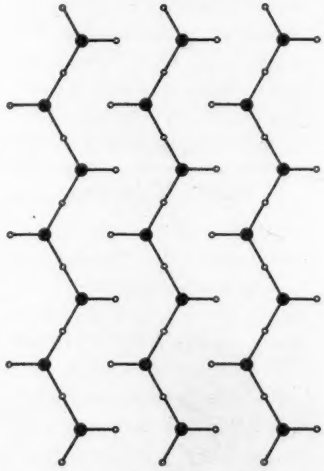


FIG. 7*B*.—A two-dimensional representation of the arrangement of layers over each other in a crystal of P, As, Sb, or Bi.

atom being bonded to two others within the same spiral. There are no bonds connecting different spirals. Such a structure may be described as being composed of "*string molecules*." It is quite possible that cellulose and a number of other organic substances are built up of such "string molecules."

Island Molecules

Most crystals of organic compounds, as well as those of quite a few inorganic substances, are built up of molecular units containing only a few atoms. For instance, in stannic iodide crystals there are definite SnI_4 groups, each tin atom being tetrahedrally surrounded by, and bonded to,

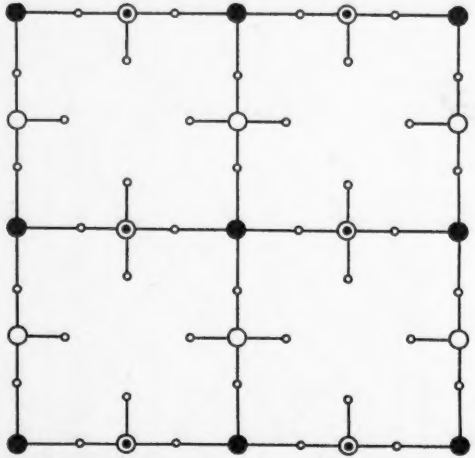


FIG. 8.—Illustrating the arrangement within a layer of HgI_2. The large dots denote Hg centers, all in one plane, and the large circles and circled dots represent I centers in planes above and below the Hg plane. The small circles represent pairs of valence electrons.

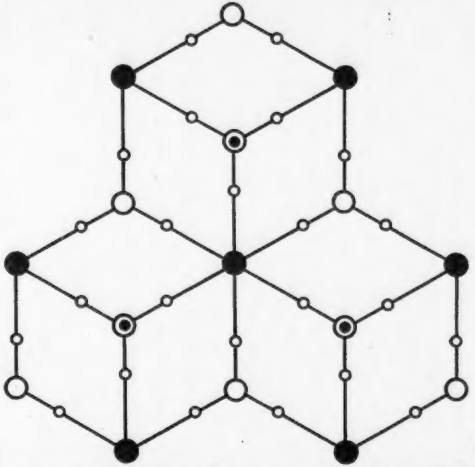


FIG. 9.—Illustrating the arrangement within a small section of each layer in a crystal of CdI_2 or $Mg(OH)_2$. Large dots represent Cd (or Mg) centers, in plane 0; large circles and circled dots represent I (or O) centers, in planes +1 and −1, respectively; small circles represent valence electron pairs. Each I (or O) center is tetrahedrally surrounded by four pairs, one being directly over or under the atomic center. In $Mg(OH)_2$ there is also a hydrogen center directly over or under each O center.

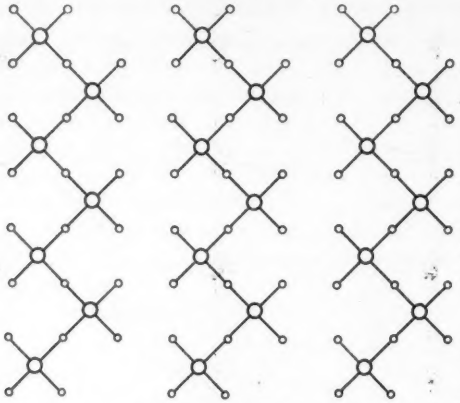


FIG. 10.—A two-dimensional representation of the Se structure. Large circles represent Se centers and small circles valence pairs.

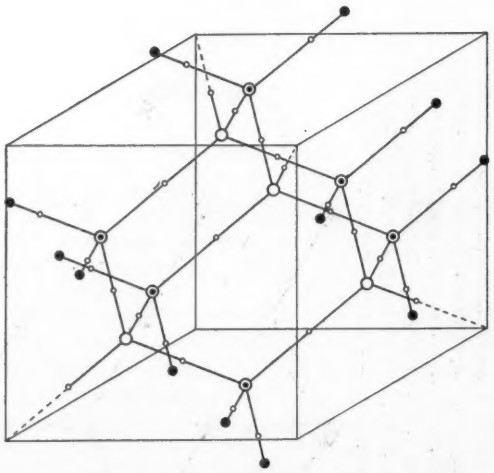
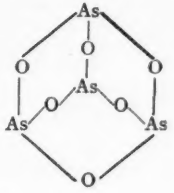


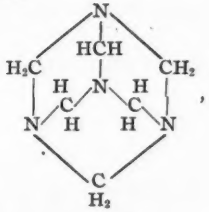
FIG. 11.—The molecular unit (not the unit cube) of hexamethylene-tetramine, $C_6H_{12}N_4$. The large circles represent N centers, the circled dots C, the larger dots H, and the small circles electron pairs. This figure will also serve to depict the structure of the As_4O_6 molecule if the large dots are neglected and the large circles and circled dots are taken to represent As and O atoms, respectively.

four iodine atoms, in agreement with the formula $:\ddot{I}:\ddot{\underset{\ddot{\underset{:\ddot{I}:}{\ddot{\underset{\ddot{}}{}}}}}{Sn}}:\ddot{I}:$

The "trioxide" of arsenic contains As_4O_6 units (Fig. 11) corresponding to the formula,



Hexamethylene tetramine,



is similar, arsenic atoms being replaced by those of nitrogen, and oxygen by CH_2 groups.

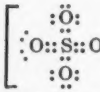
In carbon dioxide the three atoms in the molecule are in a straight line, as would be expected from the formula $:\ddot{O}::C::\ddot{O}:$.

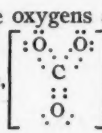
In crystals of penta-erythritol, $C(CH_2OH)_4$, the central carbon atom is not tetrahedrally surrounded. The other carbon atoms are at corners of a square, with the central carbon somewhere on the four-fold symmetry axis passing through the center of the square. Whether or not this square arrangement exists also in solution or in the liquid or gaseous states is another question, to which we do not know the answer.

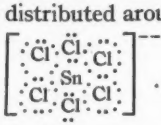
Complex Ions

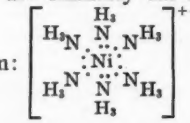
The structure of pyrite, FeS_2, is like that of sodium chloride (Fig. 4), with the sodium "ions" replaced by divalent iron "ions" and the chloride "ions" replaced by S_2^{--} groups. (Although convenient to speak of such a structure as being composed of "ions," this use of the word is questionable; each iron atom is bonded by semi-polar bonds to six sulfur atoms and each sulfur is bonded by semi-polar bonds to three iron atoms, as well as by a non-polar bond to another sulfur.)

FeAsS and $FeAs_2$ are similar, with $\left[:\ddot{As}:\ddot{S}:\right]^{---}$ and $\left[:\ddot{As}:\ddot{As}:\right]^{----}$ groups instead of $\left[:\ddot{S}:\ddot{S}:\right]^{--}$ and with the iron kernels having charges of +3 and +4, respectively, instead of +2.

In crystals containing sulfate groups each sulfur is tetrahedrally surrounded by four oxygens. The available data favor the structure represented by the formula, , rather than that represented by  , although the evidence is perhaps not conclusive.

Calcite, $CaCO_3$, contains CO_3 groups in which all three oxygens are equivalent. The X-ray data are best explained by the structure,  , which may or may not persist in solution.

X-ray data from K_2SnCl_6 show that there are six chlorine atoms octahedrally distributed around each tin atom, as would be expected from the formula  .

In $Ni(NH_3)_6Cl_2$ there are similarly six nitrogens octahedrally placed around each nickel atom:  .

Hydrogen in Crystals

One form of ammonium chloride has a structure like that of cesium chloride (Fig. 5), with the cesium "ions" replaced by tetrahedral NH_4^+ "ions." The hydrogens are on the N–Cl centerlines serving to "bond" the nitrogen and chlorine atoms together, in all probability in the manner indicated in Figure 12. Each hydrogen atom is bonded to two atoms at once, although one of the bonds must have been formed by a "secondary valence reaction."[4]

A similar state of affairs exists in ice, if we assume to be correct the only structure which has been shown to be in agreement with the available X-ray data. Each oxygen is tetrahedrally bonded to four hydrogens; each hydrogen is bonded equally to two oxygens (Fig. 13).

The X-ray data on $NaHF_2$ and KHF_2 similarly indicate that in these substances hydrogen is bonded to two other atoms at the same time: .

[4] Cf. Article III of this series. THIS JOURNAL, 3, 1426–9 (Dec., 1926).

Hydrogen is of course not bonded to two atoms in this way in all crystals. The high temperature form of NH_4Cl, for instance, has the NaCl type of structure (Fig. 4), with the hydrogens on the cube diagonals.

Metals

Most of the metals crystallize with either the hexagonal or the cubic "*close-packed*" structures (Figs. 3 and 4), in which each atom is surrounded by twelve others, the maximum number possible. The valence electrons seem to have little effect on the type of structure; they are probably not held very tightly in any definite positions, or at least are quite free to move from one "equilibrium position" to another.

FIG. 12.—Illustrating the approximate relative positions of adjacent atoms and valence pairs in a crystal of the low temperature form of NH_4Cl. (The position of the H nucleus on the N–Cl centerline is at present not known, even approximately.)

A few of the metals crystallize with the body-centered cubic arrangement (Fig. 5).

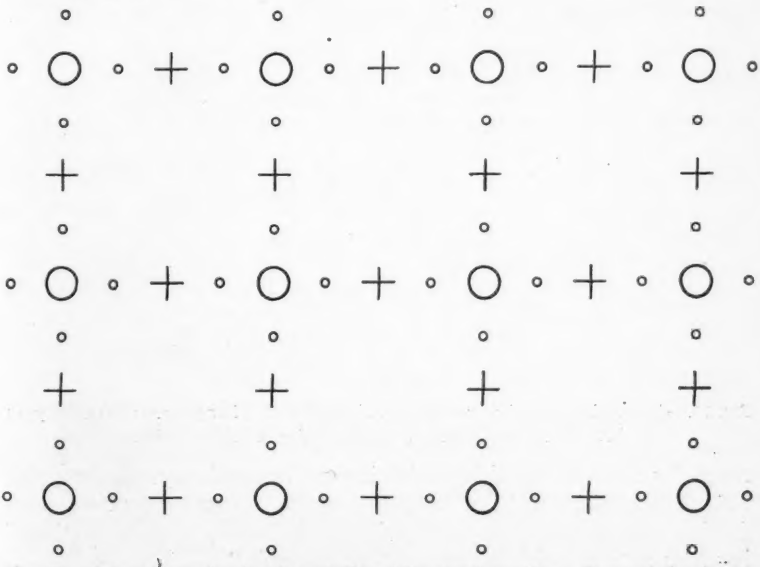


FIG. 13.—A two-dimensional representation of the structure of ice. Large circles denote oxygen kernels, crosses H nuclei, and small circles valence pairs.

Other Crystals

Many more crystals have been studied by means of X-rays, but the above results may be considered as typical. In nearly every case the data are

in agreement with a tetrahedral arrangement of four electron pairs in the valence shell of each electronegative atom. The kernels of electropositive atoms in crystals containing electronegative atoms as well are also often surrounded by four electron pairs, but in many other cases there are six or eight pairs.

Crystal Formation and Secondary Valence

The tendency to form such valence shells, containing four, six, or eight pairs, around the kernels of the more electropositive atoms seems to be

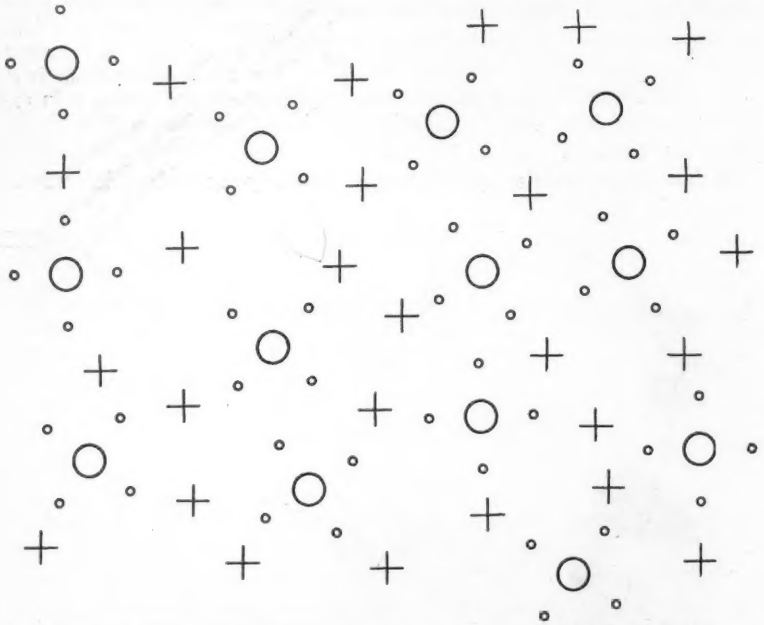


FIG. 14.—A two-dimensional representation of liquid H_2O. Large circles denote oxygen kernels, crosses H nuclei, and small circles valence pairs.

the major cause of crystal formation in most inorganic crystals containing both electropositive and electronegative atoms. In such cases the crystallization process consists of a succession of "secondary valence reactions," in which a "lone pair" becomes a "bonding pair."

Amorphous Solids; Liquids; Solutions

In amorphous solids the arrangement of atoms or molecules is irregular, but does not vary with time; in liquids the arrangement is constantly changing.

A liquid like carbon tetrachloride undoubtedly consists of CCl_4 molecules in continually changing relationship to each other; but two somewhat

different pictures have been proposed for a polar liquid such as water. The traditional view is that it consists of molecules of H_2O, $(H_2O)_2$, $(H_2O)_3$, and perhaps others, in tautomeric equilibrium with each other. The probable structure for ice, mentioned above, suggests, however, that the whole liquid, like the whole crystal, is a single molecule, but of constantly changing structure. A two-dimensional representation of the instantaneous structure of such a liquid is shown in Figure 14. Much can be said in favor of this latter view, which is the one the author believes to be correct.

We used to picture a dilute solution of a strong electrolyte as containing ions and un-ionized molecules in equilibrium with each other; but according to the "interionic attraction theory" of Debye and Hückel, which seems to be in much better accord with the experimental facts, such dilute solutions contain few or no un-ionized molecules. Instead, it is assumed that on the average each positive ion has immediately around it a slight excess of negative ions and each negative ion is similarly surrounded by a slight excess of positive ions.

Balloon Experiments Support Einstein Relativity Theory. Midnight balloon ascensions a mile and a half high made recently in Belgium may prove to be strong evidence in favor of Einstein's theory of relativity, and contrary to the results obtained by Dr. Dayton C. Miller, of the Case School of Applied Science at Cleveland, working at the Mt. Wilson Observatory in California, which were supposed by some authorities to be fatal to the German's theory. These balloon experiments, just published, were made by Prof. A. Piccard and Dr. E. Stahel, of the University of Brussels.

Dr. Miller's experiments were said to indicate a drift of the ether which is supposed to pervade all space and in which light travels. This drift was presumably due to the motion of the earth in its orbit through the ether and the experiments indicated that while an almost negligible result had been obtained when they were performed at sea-level, at the mile-high top of Mt. Wilson, there was an appreciable drift. This variation with height could not be explained by the Einstein theory.

In the new work, Dr. Miller's experiment, which was first performed many years ago by Dr. A. A. Michelson, of the University of Chicago, and the late Dr. Edward Morley, when they were both professors at the Case School, was repeated at sea level and from a balloon. A somewhat modified form of apparatus was used, in which the records were made on a photographic film, instead of by the eye, as in Miller's apparatus. As it is necessary to turn the apparatus while the experiment is in progress, so that it successively points in different directions this was accomplished by providing the balloon with two small electrically operated propellers, turning the entire balloon about two or three times a minute. The illumination of the apparatus, which must be furnished by light of a single color, was obtained from the blue radiation of a mercury vapor lamp.

From measurements of the photographic records, it was found that there was an apparent ether drift of about four and a third miles a second. However, as the thermostat controls of the apparatus, intended to keep it at a constant temperature, were designed to work with the thermometer below freezing, and since unexpectedly higher temperatures were found the night of the ascent, the results may be in error by an amount as great as the value found. However, it was stated, they show that the value of the ether drift does not increase, the higher above the earth the observations are made, which was the chief point of antagonism with the relativity theory.—*Science Service*

A NOVEL CHEMICAL QUIZ*

CORA MORTON, NORWOOD HIGH SCHOOL, NORWOOD, OHIO

(The letters in each italicized unit will, if rearranged, form the name of one chemical element. The elements are correctly spelled though some of the phrases in the puzzle are purely phonetic. Any punctuation occurring within a phrase is to be disregarded.)

The *dog Henry* Watkins gave me I wanted to call Sport or Toodles or something like that, but Anne, my wife, bestowed on him the poetic name of Colin. He really is my dog, but Anne invariably calls him *her Colin*. When she feeds him scraps from the breakfast table *I butter my* toast and pretend I don't see what she is doing.

Last summer we went camping in a *dale* at the foot of *Mount Rist*. We had a *snug tent* and Anne borrowed her cousin *Mamie's gun*. The night before we left we had a farewell game of bridge with our neighbors. I don't care much for bridge, I prefer *Music and* such things, but *Anne's game* is very scientific and often, *I as dummy, pore* over her fine play. I make a *noble dummy*. I'm *no crab* when it comes to appreciating my own or other people's specialties. Anne won a prize that night; it was a hideous piece of bric-a-brac that looked like a heathen *idol in a mug*.

It was a *murcie* our tent had a good roof, for early one morning it rained so hard that when we looked out afterward the ground about us was nothing *but mire*. We were *not in* the worst of it but things were bad enough and at first we thought that we could neither leave the tent *nor get in* again if we once got out. In a near-by field I saw a *nise mule* eating a farmer's *pe crop*. "*Hi, mule!*" I called. At once a man appeared around the corner of the tent. He had a long rope *in coils* about his arm and he tried to lasso the mule. Unfortunately, he slipped in the mud and went down with a *groan*.

"*May I n-not* help you?" I asked, stammering because I was trying not to laugh. "My name *is Crane*—Paul *Verlis* Crane. We evidently belong to the same lodge, for I see your emblem—*a tin plum*." And I *laid a plum* in his palm as our ritual demands.

"*Nit*," snorted the farmer, on his feet by this time. "I don' understand *none* o' that nonsense. I told *Maria sum* bad luck would come o' my findin' that badge, but all she said was, *I must soap* the heel o' my shoe to keep the bad luck away. Huh?" He looked at me belligerently. *I, in mud* to my ankles, grinned. "I thought you was tryin' to steal my mule," he explained half-apologetically; "to *rob me in* broad daylight. I'll not let any one do that; I'll give him a *foul rein* if he tries." With that he departed. Ever since I have wondered what a foul rein can be. I think he must have meant a *licken*.

*EDITOR'S NOTE.—The author, in submitting this quiz, apologizes for its "foolishness," but suggests that it may prove useful on the day before a long holiday or on some other demoralized occasion, when the usual lesson would be but ill received.

Answers

Hydrogen, Chlorine, Ytterbium, Lead, Strontium, Tungsten, Magnesium, Scandium, Manganese, Praseodymium, Molybdenum, Carbon, Gadolinium, Cerium, Terbium, Niton, Nitrogen, Selenium, Copper, Helium, Silicon, Argon, Antimony, Arsenic, Silver, Platinum, Palladium, Tin, Neon, Samarium, Potassium, Indium, Bromine, Fluorine, Nickel.

UNITED STATES CIVIL-SERVICE EXAMINATION

The United States Civil-Service Commission announces an open competitive examination for Junior Chemical Engineer.

Applications for junior chemical engineer must be on file at Washington, D. C., not later than February 12th. The date for assembling of competitors will be stated on their admission cards and will be about ten days after the close of receipt of applications.

The examination is to fill vacancies in various branches of the Government service throughout the United States.

The entrance salary in the District of Columbia is $1860 a year. After the probational period required by the civil-service act and rules, advancement in pay will depend upon individual efficiency, increased usefulness, and the occurrence of vacancies in higher positions. For appointments outside of Washington, D. C., the salary will be approximately the same.

The duties consist of routine testing, preparing specifications for engineering material or apparatus, making computations, assisting in conduct of experimental research tests, compiling reports, handling technical correspondence, and other related work.

Competitors will be rated on general physics, mathematics, general engineering, and chemical engineering.

Full information and application blanks may be obtained from the United States Civil-Service Commission, Washington, D. C., or the secretary of the board of U. S. civil-service examiners at the post-office or customhouse in any city.

U. S. Chemical Warfare Service Has New Poison for Boll Weevil. The Chemical Warfare Service makes an announcement which it is expected will relieve the minds of many people vitally interested in the continuance of the supply of cheap calcium arsenate now used extensively in the warfare against orchard insects and especially against the cotton boll weevil. The officers of the service do not say just what are the substitutes discovered but state that should an emergency arise or the price of calcium arsenate increase too much, the service is prepared with substitutes to correct either evil.

It is only a few years since the supply of calcium arsenate on hand was so depleted as to arouse serious fears. The use of arsenicals in war operations and the greatly enlarged demand for calcium arsenate from cotton planters in the South occasioned this great reduction of the poison and resulted in so great a rise in price as to make it almost prohibitive to cotton planters.—*Science Service*

A CHEMICAL PARTY

ARTHUR T. BAWDEN, OTTAWA UNIVERSITY, OTTAWA, KANSAS

A real chemical party helps a lot in keeping the interest of the students in the spring of the year. It may be given by the student chemical society, or by the whole department of chemistry in the smaller schools. The following motto on our lecture desk in the class-room is constantly before the students, "Anything worth doing at all is worth doing well." We try to make our parties so thoroughly enjoyable that the students will want to take chemistry just to be able to attend a chemical party. Every student who attended the chemical party last year, at a college where students know how to do something else besides dancing for their entertainment, said that it was the best party of the year. The outline of this party, with a few changes, is given in this paper with the hope that it may furnish some ideas to other teachers when their students come to them for suggestions.

It is as important to keep the students busy every minute at a party as it is in the class-room. It is also as important that the person in charge of the entertainment have the ability to make himself heard and obeyed at a party as it is for the teacher in the class-room.

Invitations to the party are written with a sympathetic ink consisting of very dilute sulfuric acid, using a clean steel pen. The invitations are written on apparatus sheets or other paper which has printed matter related to chemistry. After the invisible writing has dried, across the middle of the sheet are written the words, "Heat and Read," using a dilute tincture of iodine. When this paper is heated the brown writing, "Heat and Read" disappears, and the invisible invitation comes out as a black writing resembling India ink. Each invitation bears R. S. V. P. on it, and the invitations sent to the men contain a request to bring five pennies.

It is now time for the party. The first guest arrives. When he touches the knob of the front door he receives an electric shock. A wire door-mat has been placed in front of the door. A student stationed where he can command a good view of the entrance presses a button when someone touches the door knob, which completes the circuit from a small induction coil operated by dry cells, to the door knob, through the body of the guest to the wire door-mat. This is continued until the guest figures out some non-conducting device to use in turning the knob, or until he gives up, when he is allowed to enter. A couple of students who are taking physics can be assigned the task of fixing up the induction coil and operating it.

The guests are then met by one of the senior girls who introduces them to the president of the chemical society or some other prominent member of the department. The guest is required to wash his hands before shaking

hands with the president. A bowl of dilute ferric chloride solution is provided for this purpose. Then, while his hands are still wet he shakes hands with the president. The president has some powdered tannin in the palm of his hand, which, of course, forms an ink-like stain on the guest's hand. The president's hand becomes black also, so the operation must be carried on in subdued light and he must not expose his hand unnecessarily. The guest is then provided with a towel to dry his hands on. This towel has previously been soaked in a solution of tannin and dried, so that it only makes things worse for the guest. The president cleans his hands with a solution of oxalic acid when all of the guests have been received, but the guests are not given this opportunity, as they are supposed to take this stain on their hands home with them as a memory of the party.

The events of the party will be described from now on in their chronological order.

7:30 to 7:50—Formula Mixer.

In order to break the ice and get acquainted, as well as to provide something for everyone to do until the majority of late-comers have arrived, the following plan is used. After a dozen or more students have arrived, they are told that three of the students have prizes, which can only be obtained by shaking hands with one of these students and saying the correct formula. Simple formulas such as H_2S, H_2O, HCl, NH_3, etc., are used. All other students are told about this upon their arrival at the party. Large sticks of candy are given as prizes.

7:50 to 8:10—Spider Web.

This works very nicely where the chemistry building or some other large building is used for the party. The mixer is held on the lower floor. The upper stairways, halls and rooms are a veritable spider web of strings. One string has been prepared for each person, using about one-third of an ordinary fifteen-cent ball of twine per person. A prize is attached to one end of the string, and a rubber stopper to the other. The stopper end of each string ends in the lower hallway, where each person is given one. Several people are required to spend two or three hours laying out the strings. After they are all in place some nitrogen iodide, freshly prepared, is dabbed on the strings at different places, and on the floor.

In place of the spider web, a dress-making contest may be held. The guests are coupled off and each girl is provided with a small paper of pins, newspapers, and a picture of one of the well-known chemists of a hundred years ago. She is given fifteen or twenty minutes to dress her partner as nearly as possible as the man in her picture is dressed. She is also provided with a large label bearing the name of the chemist whose costume she is copying. When the time is up each man, dressed and labelled, forms

in line and passes before a committee of judges for inspection. First and second prizes are offered to the winning couples.

8:10 to 8:40—Initiation.

The final steps in the initiation of new members into the chemical society take place at this time. All but the new members are admitted into a large room, kept locked up until this time, and seated around the sides of the room.

The first step, and the most entertaining one is the search for the "Philosopher's Stone." A long table is placed in the center of the room. On the center of the table is placed a large square of pasteboard, coated an hour previously with varnish. In the center of this is placed a fairly large pasteboard box, varnished all over, including the lid. Inside of this is a small box containing some glass-wool moistened with pyridine. Inside of this box is another one containing the "Philosopher's Stone," wrapped up in glass wool moistened with a concentrated tincture of asafetida. On the floor around the table and at different points on the table and its contents are placed small dabs of nitrogen iodide. Different objects such as stones, pans of water, ammonium hydroxide, and other liquids, raw oysters, liver, etc., are placed on the table at different points.

The candidate is brought in, blindfolded and told to find the "Philosopher's Stone" on the table and that he will be notified when he finds it. He is provided with a rubber apron and sleeves. Only a few members can be initiated during this one evening. It will be very difficult to find a greater laugh producer than this search for the "Philosopher's Stone," for each student goes at the thing in a different way.

It may be followed by giving the candidate a drink of a dilute solution of methylene blue, branding with silver nitrate solution or a tincture of iodine. The latter works very nicely. Immediately after applying the tincture of iodine, apply a lighted match, which will set fire to the alcohol. It is all consumed before a burn is caused, but not before the spot becomes distinctly hot. The last step in the initiation may consist of a short ritualistic ceremony, but whatever is done should be in the way of entertainment for the members, and should be harmless.

8:40 to 8:50—Stopper Hunt.

While the initiation is taking place, one or two students should hide some old cork and rubber stoppers around the building. First and second prizes are offered for students finding the most stoppers in eight minutes.

8:50 to 9:30—Chemical Contests.

Everyone now enters a large room, going to the group which is designated by the paper which he receives as he enters the room. Filter papers, dyed blue, are prepared as follows: Using a chemical stencil, similar

pieces or combinations of pieces of chemical apparatus are drawn on each pair of papers using a red crayon. Each paper will also contain the name of an acid, base, or salt, and half of the formula of one of these compounds. The boys are given the papers containing the first half of the formula, and the girls are given the papers containing the other half. The number of acids, bases, and salts are equally divided. Each student is provided with a pin to attach the paper to the coat or dress.

The students are then divided into three groups, acids, bases, and salts. Each group is assigned a separate part of the room and is instructed to elect a captain. The captain selects representatives for each of the different contests, using different people in each case, if possible. The score is kept on the blackboard as the contests proceed. The group obtaining first place in a given event is given three points, second place receives two points, and third place one point. Prizes are given for each place, but the first prize must be much better than the second prize, etc. Each prize should be such that every member of the group can enjoy it. The following contests are held.

1—Bowling.

Three sets of nine 250-cc. reagent bottles are set up up-side-down, like bowling pins. One representative from each group is given a pan containing twenty rubber and cork stoppers of assorted sizes, and stationed at a distance of ten feet from his set of bottles. The student who succeeds in knocking over the most bottles wins.

2—Stopper in the Pan.

One representative from each group is given a vessel containing twenty-five rubber stoppers and is stationed at a distance of ten feet from a shallow pan. The student who succeeds in getting the most stoppers in the pan wins.

3—Water Pouring.

One representative from each group is given a wide-mouthed vessel with no lip, containing a certain amount of water. He is stationed on a chair or box, and pours the water into some test tubes held in a test-tube rack, which is placed on the floor at the foot of the box or chair. A string is fixed at a certain height, below which the student is not allowed to hold the pouring vessel. The water which the contestant succeeds in getting into the test tubes is measured with a graduated cylinder. The contestant who pours the most water into the test tubes wins.

4–Indicator Contest.

One representative from each group is given a large four-liter beaker half full of water, a glass stirring rod, and thirty small reagent bottles containing dilute hydrochloric acid, concentrated hydrochloric acid, dilute

sodium hydroxide, concentrated sodium hydroxide, water, etc. Each contestant receives the same bottles, filled with the same reagents, and placed in the same order. One of the small bottles of each set contains ten drops of phenolphthalein indicator in distilled water. The contestants are told that the right combination of bottles will produce a pink color, which must be produced throughout the solution in the large beaker. The first one to succeed in obtaining the pink color wins.

5—Formula Contest.

One representative from each group is given a number of large letters and numbers drawn on separate sheets of paper, and told to use them all in making one formula. Each contestant receives the same letters and numbers. The first one to use up all of the sheets in making a formula wins. $CuSO_4.5H_2O$ makes a good formula since nine sheets are required. More difficult formulas may be used if desired.

6—Chemical Identification.

Thirty bottles containing the following substances are placed on a table. Br, Butyl ether, $NiCl_2$, HCHO, $Cu(NO_3)_2$, C_5H_5N, H_2O, CS_2, $C_6H_5NO_2$, $Co(NO_3)_2$, $Na_2Cr_2O_7$, S, CHI_3, K_2CrO_4, HgI_2, Sn (Mossy), Zn (Mossy), kerosene, Pb_3O_4, KOH (stick), $(NH_4)_2CO_3$ (lump), I (crystals), $KMnO_4$ (solution), CH_3COOH, NH_4OH, C_2H_5OH, $CHCl_3$, Hg, Cane sugar, NaCl.

Three representatives from each group come to the table, the representatives from each group coming separately. Each representative is supplied with a piece of paper and a pencil, and is given five minutes to write down his guesses as to the nature of the substances, using either names or formulas. No regular order is required. The group whose three papers contain the largest number of correct substances wins the first prize.

9:30 to 10:00—Play: The De-Evolution of Man.

This is an optical illusion stunt and requires one or two rehearsals for success. The front of the room or stage is covered with a black background made from black, dark green, or dark blue curtains or cloth, or from lining paper coated with a paint made from sodium silicate solution and lampblack. Two side curtains, four or five feet wide, are provided about four or five feet in front of the rear curtains. In front of these side curtains, placed on uprights on each side, are two or three electric light bulbs with their reflectors facing the audience. This partially blinds the eye to objects on the stage. All other lights in the room are shut off after the preliminaries are over. The audience should be kept at least ten feet away from the front of the stage.

This play requires from ten to fifteen characters depending upon the amount of doubling which is employed.

Preliminaries:

Mrs. Rufus Rastus is pressing some trousers at the front of the stage as the curtain rolls up, and saying the following to herself:

"This sho is some job my Rastus hab got. Just cogitate! All he hab to do is to tend to the Central Heating Plant (make this fit local conditions), and go ober to the chemistry building several times each night to see that there are no floods an' no conflagrations. Prexy ————, he says we can fix up a place in dis here basement (see note above), and lib here an' eberting. I sho do wish Rufus Rastus would hurry back. Massa ———— say that dis building am haunted, but he can't fool me. Still, see'ins this is our first night heah, I wish Rufus was heah. I do hope he ain' caught. I tol' him to be sure no one was looking, but I sho do hope he fetches back some of dat er poultry, so we can celerbrate our first night heah."

She begins to laugh to herself, and continues. "Dat sho was a good joke about young Johnny Brown. The other day Johnny passes by heah where Rufus was burning grass, an he say, 'Don't do that, Uncle Rufus, don't do that.' An Rufus says, 'Why so, sah, why so?' An' Johnny says, 'Cause you will make that meadow as black as you are.' 'Neber min' dat, sah, neber min' dat,' say Rufus. 'Dat grass will all grow out an' be as green as you is.' "

Mrs. Rastus thus tells two or three jokes on local characters and then continues, "Where's dat Rastus? I hope some dog didn't smell dat hydrogenum sulfidus gas what Rastus always brings wib him from dat smelly old chemicalstry place."

At this point she screams as the sound of breaking glass is heard. Enter Rastus with gunny sack over his shoulder. Mrs. Rastus screams again as he enters.

Rastus: "What's wrong?"

Mrs. R: "Lordy, I thot you was a ghos'."

Rastus: "Ghos', Niggah Lips! Ghos'! Der ain't no such animal."

Mrs. R.: "Den what make dat noise?"

Rastus: "I was bringin' one of Prof. ————'s big Py-y-r-rex beakers ober to cook in when I just got outside and somin scairt me, and I dropped the beaker."

Mrs. R.: "What scairt you?"

Rastus: "I thot I saw a skeleton."

Mrs. R.: "A skeleton? O-oh I don' wanna lib heah 'tall. Ain't you afraid?"

Rastus: "Skeletons ain't nothing but dead bones. But anyway I tell you I don't know whether I like dis job or not. Las' night when I went ober to look for conflagrations at dat old Chemicalstry Laboratory I was walkin' along, when deh was a big explosion right where I was stan'in'. It scairt me so, dat firs' thing I knew I was down in Prof. ————'s easy

chair a restin' up. I must a gon a sleep, because Ah had the most awful nightmare. I dreamed I was a settin' there, an' along come a great big yallar molecule. It says I am a Sulfur molecule an I hab come to make you suffer. Den I looked closer an' I saw dat the molecule had eight funny cube things, an' each cube had two cubes inside of it, an' on the corners of the cubes there was real bright little lights, an' in the center I saw a great big cross."

"Den while I was lookin' these bright lights began to travel roun' and roun' the middle, and the cross became a king on his throne, and all these lights spun aroun' so fas' that they made me dizzy."

"Den I saw two funny lookin' couples come in and they had hold ob one of these sulfurs and were pullin it up, and the sulfur was pulling down, an they fought so hard that the air began to smell like rotten eggs, an' I began to get dizzy and fell down on the floor, an' a whole troup of these light things, what called themselves Hydrogenum molecules, come an carried me up into the sky. Just then Prof. ———— come in and asks me why I was all gray like, an' I tol' him, an' he say the atoms were after me. He say ebrything is made up of moving particles, and that even dead bones were constantly moving, but I tol' him dat de theory was all right, but the practical application to me was all wrong. Den he went on an' tol' me about sixteen elemental tings wib funny names, which he say we all made up of, more or less, but den I lef cause it was gettin' too deep fer me."

"Well, Niggah Lips, you all go out an fix us these heah chickens, while I finish those trousers."

Mrs. Rastus leaves the stage and Rastus begins to press the trousers, which are extraordinarily large.

"Golly these trousers am big. No wonder Mis. ———— don' wan' to press 'em. Well, I guess I will lie down and res' just a minit."

Rastus lies down on a couch or bed at the side of the stage in front of the black side curtains where the lights will shine on him, and in such a position that he can see what takes place on the stage. What follows is the dream that he has. He pulls a cover up over himself. Later he becomes all entangled in this cover as he kicks and groans at the different figures that appear on the stage. He tries to hide under the cover, sits up in bed, hides behind the side of the bed when the skeletons come in, and, in general, conducts himself like one having a nightmare. When the real skeleton comes in he lets out a blood-curdling yell, reaches under his pillow, grabs a pistol, and shoots a couple of blanks at the skeleton, which immediately disappears, as described later.

All lights, except the side lights on the stage, are turned off as Rastus goes to sleep.

There is a rattle of chains. A ghost (someone dressed in a sheet) appears in the middle of the stage. Two people dressed in black carry a

black curtain in front of the ghost as it enters from the side. When in the middle of the stage they suddenly drop the curtain and the ghost seemingly appears out of space. The lights in front of the side curtains must be so adjusted that no one in the audience can detect these black figures.

The ghost makes some motions at Rastus, then goes to the center of the stage and takes a white chair which has come with a wave-like motion from the side of the stage toward him. In like manner he takes a white table, pitcher, and cup out of the air. These are all carried in by someone dressed in black. The ghost sits down at the table and pours some water from the pitcher into the cup. A deep voice says, "This is the Elixir of Death." The ghost then throws the water at Rastus, who lets out an awful yell as it wets him. The furniture and, finally, the ghost all disappear just as they entered, the ghost stepping behind the black curtain on the floor, which the two black figures then jerk up in front of him.

Then a white arm and hand appear in the same way that the ghost did, and write on a blackboard with white chalk, "Beware of the Living Atoms." Both mysteriously disappear by use of the black curtain again.

Then a series of figures passes from one side of the stage to the other, in such a way that only one figure is on the stage at a time. These figures are made by use of black and white clothes and cloth. The following figures appear in the order given:

A man all dressed in white,
A headless figure,
A head,
Head and legs below the knees,
Trunk and legs above knees,
Two arms,
One arm and one leg,
One arm,
One leg,
One arm,
One leg,
White trunks and white shoes,
White shirt with tails out,
Two eyes, belt, hands, and feet.

Then a dance is given by two figures dressed as opposites, the one being white where the other is black. They should give a very short dance taking care never to pass in front of each other.

After a minute's pause, four skeletons suddenly appear in the center of the stage. Uniforms are made out of black cloth, painting the skeleton on the cloth with white paint. The people taking this part are covered

with black material from head to foot in the back. They come on the stage with their backs to the audience and, on the signal from their leader, they all quickly about face. This method is used throughout the dance which they now give, to appear and disappear. Two very tall men and two very short men make a good combination. The legs must move sidewise in the dance in order not to get in front of each other. The two large skeletons which are in the center suddenly disappear, the small ones close in, and soon the large ones suddenly appear on the outside. The skeletons then take alternate places, first a large one and then a small one. They disappear, one by one, only to appear again at the other side of the stage, etc. A little care in making the uniforms and working out the dance will result in an effect which is quite realistic and mystifying.

Finally all of these skeletons disappear and a real skeleton, with a little white phosphorus rubbed in the eyes and teeth, appears in the center of the stage. It comes right out to the couch, or as close as it can, without revealing the person who is holding it. The arms are moved toward Rufus, who exhibits the greatest terror. Then the skeleton moves back toward the center of the stage, and Rufus fires his pistol at it. At the moment the pistol is discharged, two black figures raise the black curtain in front of the skeleton. On this curtain are painted in white letters the symbols for the sixteen elements, C, H, O, N, Cl, F, I, Fe, Ca, P, K, Mn, Mg, Na, S, Si, which are found in the human body. They are so arranged that they all seem to be scattering from a central point where the skeleton was. When the skeleton first came on the stage, the curtain was brought in with the black side toward the audience, but after lowering it, it was reversed, so that the side with the white letters on it faced the audience, when the curtain was jerked up in front of the skeleton.

This concludes Rufus' dream. The curtain with the white letters is lowered in a moment, and the black figures take it off of the stage. The lights are turned on, only to reveal a stage as bare as it was before the dream started. Mrs. Rastus rushes in and asks what the noise was, Rufus waking up as she enters. Rufus tells her that he has been having a most awful nightmare about men, ghosts, skeletons, etc., and that he just blew the last skeleton to atoms.

10:00 to 10:30—Refreshments.

Each person now finds his partner, using the marked filter papers given to them earlier in the evening, unless this has been done before the play.

During the play a long rope has been strung around the rooms on one floor. This must be followed in the dark in order to obtain the refreshments. This rope passes near powerful odors and has different objects tied to it, according to the imagination of the committee. It leads each couple to five small shelves placed in different rooms. These shelves are

made on a panel, made from beaver board, fitting into doorways. On each shelf is a small, lighted candle. On the panel above the shelf is some chemical formula or expression indicating what article is to be obtained at this stop. A slot, to drop a penny in, is indicated, and when the penny has been dropped in, a small door opens, and the given article, such as a plate, napkin, ice-cream, punch, or cake, is received. All candles, panels, lettering, etc., are blue. The refreshments, paper plates, napkins, etc., are dyed blue.

The refreshments are finally taken into a dark room, lighted with a few candles placed at different parts of the room. While the people are eating, some phonograph music is played. When it is about time to go home, about fifty to one hundred cubic centimeters of benzoyl chloride are poured on a radiator, or some other place which will insure quick volatilization, and which is situated near the door. Care must be taken that no one observes the person who does this. Very shortly every one leaves for home. They are given a final send-off by stepping on a lot of nitrogen iodide dabs, which were placed in the entrance of the building after the arrival of all of the guests, but soon enough to allow it to dry.

United States Civil-Service Examination for Junior Patent Examiner. Applications for junior patent examiner must be on file at Washington, D. C., not later than January 29, 1927. The date for assembling of competitors will be stated on applicants' admission cards, and will be about ten days after the close of receipt of applications.

The examination is to fill vacancies in the Patent Office at Washington, D. C., and in positions requiring similar qualifications.

The entrance salary is $1860 a year. A probationary period of six months is required; advancement after that depends upon individual efficiency, increased usefulness, and the occurrence of vacancies in higher positions.

The duties will be to perform elementary scientific or technical work in the examination of applications for patents; to see what the alleged inventor thinks he has produced that is new, and to see that the disclosure is complete; and to investigate the prior art as represented by patents already granted in the United States and various foreign countries and by the descriptions in technical literature.

The applicant must select one of the following optional subjects: Civil engineering, electrical engineering, mechanical engineering, chemical engineering, electrochemistry, and general chemistry.

Competitors will be rated on physics, mechanical drawings, technics, the optional subject selected, mathematics, and French and German.

Full information and application blanks may be obtained from the United States Civil-Service Commission, Washington, D. C., or the secretary of the board of U. S. civil-service examiners at the post-office or customhouse in any city.

POSITIONS OPEN TO GRADUATE STUDENTS MAJORING IN CHEMISTRY, IN VARIOUS COLLEGES AND UNIVERSITIES

Below are listed various Fellowships, Scholarships, and Part-time Assistantships open to graduate students majoring in Chemistry in different colleges and universities for the academic year 1927–28. It is possible here only to give a very brief statement concerning these positions. Further details as well as application blanks may be obtained by writing directly to the Departments of Chemistry in the colleges and universities listed. In general it may be stated that candidates for these positions must file their applications not later than March 1, 1927. The colleges and universities are listed in alphabetical order.

CALIFORNIA INSTITUTE OF TECHNOLOGY, Pasadena, Calif.—4 Graduate Assistantships ($750); 6 Teaching Fellowships ($900); 1 Fellowship ($750); 2 Petroleum Fellowships ($1000–$1200). The tuition ($180) must be paid until the holder has been accepted as a candidate for the Ph.D. degree, then half tuition ($90) is paid.

CATHOLIC UNIVERSITY OF AMERICA, Washington, D. C.—A number of "Knights of Columbus" Scholarships available. These include tuition, board, and lodging.

COLUMBIA UNIVERSITY, New York City.—Fellowships ($1500); University Scholarships ($300); Part-time Assistantships (from $100 to $1000); "Statutory" Assistantships ($1000 and free tuition); Research Assistantships varying in number and compensation.

CORNELL UNIVERSITY, Ithaca, N. Y.—46 Part-time Assistantships requiring twenty-two hours of work each week assisting in the department ($400–$650); also 5 Fellowships and Scholarships with yearly compensation of from $200 to $750.

HARVARD UNIVERSITY, Cambridge, Mass.—A number of Fellowships ranging from tuition to $750; also a number of laboratory Teaching Assistantships paying at least $800 for half time and requiring ordinarily from twenty to twenty-two hours a week. Tuition fee of from $150–$160 must be paid in addition to fees for breakage and certain materials.

INDIANA UNIVERSITY, Bloomington, Ind.—2 Fellowships ($350 and exemption from fees except breakage); 8 Part-time Laboratory Assistantships ($350–$500, in addition to general University fees); 1 Indiana University Fellowship ($600).

JOHNS HOPKINS UNIVERSITY, Baltimore, Md.—10 Part-time Assistantships ($400 and free tuition for about ten hours of work weekly); 2 Fellowships ($750) and one Scholarship open to holder of Ph.D. in Chemistry ($1000). In addition to the above, a number of Scholarships offering free tuition, are also open to students in Chemistry.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY, Cambridge, Mass.—9 Scholarships ($300, which is used to pay tuition charges); 5 Half-time Assistantships ($150, to pay tuition charges); and 5 students who receive scholarship aid of $500; 1 Fellowship ($750, $300 of which is used to pay tuition charges).

NORTHWESTERN UNIVERSITY, Evanston, Ill.—A number of Part-time Assistantships ($500–$800); a number of Fellowships ($500–$1000, and no service required).

OHIO STATE UNIVERSITY, Columbus, Ohio.—13 Part-time Assistantships ($1000); 30 Graduate Assistantships ($500); 2 Fellowships ($750—no service required); a number of University Scholarships ($300), and University Fellowships ($500) are also open to students in Chemistry. All of the above carry exemptions from fees (except matriculation fee of $10) and cost of chemicals.

PRINCETON UNIVERSITY, Princeton, N. J.—4 Fellowships ($650–$1100); 12 Part-time Assistantships ($650), duties not to exceed twelve hours weekly.

RICE INSTITUTE, Houston, Texas.—A number of Teaching Fellowships which require six hours of laboratory teaching per week ($750 and exemption from fees).

STANFORD UNIVERSITY, Stanford University, Calif.—A number of Fellowships ($750) and Graduate Scholarships ($200) are open to students in all departments. There is also in the Department of Chemistry a Fellowship ($600) and a Scholarship ($150) and 2 Teaching Fellowships ($600).

STATE UNIVERSITY OF IOWA, Iowa City, Ia.—There are open to graduate students a number of Scholarships ($200–$300), Junior Fellowships ($300–$400), Senior Fellowships ($500–$800), Research Assistants ($600), and Research Associates ($1000 plus). A number of Graduate Assistantships are also open ($350–$800 depending upon the amount of assistance required).

UNIVERSITY OF CALIFORNIA, Berkeley, Calif.—A number of Graduate Fellowships ($750 and no service required); also a number of Teaching Fellowships with a beginning salary of $700.

UNIVERSITY OF CHICAGO, Chicago, Ill.—A number of Assistantships ($200–$600 plus tuition, laboratory fees, and allowance for breakage); a number of Fellowships averaging about $450 but tuition must be paid; a number of Scholarships which pay tuition only; both Fellows and Scholars assist from six to eight hours a week for two quarters.

UNIVERSITY OF ILLINOIS, Urbana, Ill.—A number of Scholarships ($300) and Fellowships ($400–$750) are open in the Department of Chemistry; also a number of Assistantships varying from $300–$700 plus free tuition, laboratory fees, etc., except a matriculation fee of $10.

UNIVERSITY OF KANSAS, Lawrence, Kans.—15 University Fellowships ($400); 11 University Fellowships open to graduates of Kansas colleges alone, which are open to students of chemistry. There are also 12 Part-time Assistantships in Chemistry ($600–$1000).

UNIVERSITY OF MARYLAND, College Park, Md.—1 Fellowship ($1000); 5 Part-time Assistantships ($500).

UNIVERSITY OF MICHIGAN, Ann Arbor, Mich.—10 University Fellowships ($400–$500). There are also assigned to the Department of Chemistry 2 Fellowships ($750) and one additional Fellowship ($300); also a number of Teaching Assistantships ($800).

UNIVERSITY OF MINNESOTA, Minneapolis, Minn.—28 Assistantships ($650–$750); 3 Fellowships ($500–$750); Fellows and Assistants are exempt from tuition and fees.

UNIVERSITY OF MISSOURI, Columbia, Mo.—10 Graduate Assistantships ($600–$700); a number of University Fellowships ($600) and Scholarships ($300). No service is required of Fellows and Scholars.

UNIVERSITY OF NEBRASKA, Lincoln, Nebr.—A number of University Scholarships ($400–$500) and University Fellowships ($500–$750).

UNIVERSITY OF NORTH CAROLINA, Chapel Hill, N. C.—3 Teaching Fellowships ($500); Seven Assistantships ($500); 1 Fellowship ($300) and 2 Instructorships ($1500).

UNIVERSITY OF PENNSYLVANIA, Philadelphia, Penna.—A number of Fellowships are open to students in the Department of Chemistry. These carry varying stipends from $200 to $1500 per annum.

UNIVERSITY OF TEXAS, Austin, Texas.—25 Tutors ($725–$1200) and Assistants ($550) in Chemistry.

UNIVERSITY OF WISCONSIN, Madison, Wis.—1 Scholarship ($300); 1 Fellowship ($500); 1 Fellowship ($750).

YALE UNIVERSITY, New Haven, Conn.—24 Laboratory Assistants ($750, less fees which amount to about $250); 1 Fellowship awarded on basis of competitive examination ($1200); a number of special Fellowships averaging about $750; in addition to the above, there are a number of University Fellowships ($400) and of Sterling Fellowships ($1000 or more).

Measure Magnetism of Hydrogen Atom. The United States is forging ahead in the field of atomic physics where the brilliant theories of the Germans and Scandinavians have long held more or less undisputed sway. Experiments recently completed by Drs. J. B. Taylor and T. E. Phipps in the department of physical chemistry at the University of Illinois have produced results which throw a new angle on the quantum theory advanced by Dr. Neils Bohr, of Copenhagen, Nobel prize winner in physics, and that proposed by Drs. Max Born and W. Heisenberg of Goettingen.

Exponents of the German school have developed a theory that is based on a non-magnetic atom but the American scientists have found that the hydrogen atom is magnetic and have made a direct experimental determination of the degree of magnetism it possesses. They found that it was equal within the limits of experimental error, to one Bohr magneton, or unit of magnetic moment based on the Bohr quantum theory.

The atoms of the alkali elements such as sodium and potassium are known to behave as tiny magnets and since hydrogen is the simplest of all the chemical elements, knowledge of the degree of magnetism possessed by its atom is of great importance. All of the accepted theories of the continental school account for the spectrum of hydrogen accurately, in consequence of which a test of the nature of the hydrogen atom is of great scientific interest.—*Science Service*

Hydrocyanic Acid Poisoning May Be Prevented by Sugar. Death by hydrocyanic acid, one of the quickest and most effective ways of vacating this terrestrial sphere, quite popular with suicides a few years ago, may have a preventive in glucose, one of the simple chemical variations of sugar.

According to a report to the *Presse Medicale*, Dr. H. Violle, at the University of Marseilles, has made studies of the antitoxic effect of glucose against the poisonous gas which indicate that the sugar, either taken internally or in intravenous injections, will protect laboratory animals against the deadly fumes.

These experiments offer a possible explanation of the reported mysterious failure of Rasputin, the favorite of the former Czarina of Russia, to succumb to cyanide poisoning. Potassium cyanide is said to have been offered to the monk in a glass of port wine and in the frosting of accompanying cakes. The victim partook of all of the refreshments with great equanimity but failed to pass out as anticipated, so the conspirators fell upon him and made a good, though messier, job of it with revolvers.

Rasputin's resistance to the poison is thought to be accounted for, according to the medical report, by the sugar in the wine and the icing acting as an antidote against the poison.—*Science Service*

DOCTORATES IN CHEMISTRY CONFERRED BY AMERICAN UNIVERSITIES 1925–1926

COMPILED BY CALLIE HULL AND CLARENCE J. WEST, RESEARCH INFORMATION SERVICE, NATIONAL RESEARCH COUNCIL, WASHINGTON, D. C.

The following list of doctorates in chemistry conferred by American Universities for the academic year 1925–1926 is a continuation of the list published in THIS JOURNAL, **3**, 77–99 (1926).

Table I gives the statistics by university, by year for the period 1919–1920 to date. Table II shows the doctorates conferred in chemistry during the past seven years by eleven universities which granted ten or more doctorates in this science during the year 1925–1926.

TABLE I

DISTRIBUTION OF DOCTORATES IN CHEMISTRY BY UNIVERSITY, BY YEAR

	'19–'20	'20–'21	'21–'22	'22–'23	'23–'24	'24–'25	'25–'26
American	..	..	..	..	..	..	1
Boston	..	..	..	1	..	..	1
Brown	1	1	..	..	..	5	2
Bryn Mawr	..	..	1	..	..	..	..
California	3	6	8	11	6	8	7
Calif. Inst. Tech	1	..	2	..	3	4	7
Catholic	..	..	..	1	2	2	1
Chicago	13	16	14	12	19	14	26
Cincinnati	1	2	3	1	2	4	4
Clark	2	3	2	3	3	..	..
Colorado	..	..	1	1	..	1	2
Columbia	8	18	13	28	35	30	34
Cornell	3	8	9	8	19	14	12
Fordham	1	..	2	2	..	2	2
George Washington	3	1	..	6	3	1	2
Harvard	4	5	3	5	18	13	10
Illinois	8	7	16	19	19	18	18
Indiana	..	..	1	2	1	2	2
Iowa	..	..	..	4	3	6	10
Iowa State	..	..	..	..	4	7	8
Johns Hopkins	10	10	13	12	12	10	19
Kansas	..	..	..	..	1	3	1
Maryland	..	..	..	..	..	..	4
Mass. Agr. College	..	..	..	1	..	..	..
Mass. Inst. Tech	4	6	5	6	11	17	8
Michigan	2	6	5	2	11	2	13
Minnesota	..	..	5	3	9	8	8
Missouri	..	..	..	..	1	1	1
Nebraska	..	1	1	1	3	3	1
New York	1	3	1	6	1	3	2
North Carolina	..	2	1	1	..	..	5
Northwestern	..	..	4	..	4	1	1

TABLE I (*Concluded*)

DISTRIBUTION OF DOCTORATES IN CHEMISTRY BY UNIVERSITY, BY YEAR

	'19–'20	'20–'21	'21–'22	'22–'23	'23–'24	'24–'25	'25–'26
Notre Dame	1	..	..	1	2	..	..
Ohio State	2	5	4	13	14	23	11
Pennsylvania	..	1	3	..	4	1	7
Pittsburgh	1	2	5	6	5	7	3
Princeton	3	5	5	2	8	4	4
Radcliffe	..	1	..	..	..	..	..
Stanford	..	2	1	3	8	2	5
Virginia	1	..	1	1	2	3	2
Washington Univ., St. Louis	..	..	..	1	..	..	..
Washington	..	1	2	..	1	2	..
Wisconsin	8	9	13	14	21	26	24
Yale	12	13	13	17	8	16	18
Total	93	134	157	194	263	263	286

TABLE II

UNIVERSITIES GRANTING 10 OR MORE DOCTORATES IN CHEMISTRY, 1925–1926

	1920	1921	1922	1923	1924	1925	1926
Columbia	8	18	13	28	35	30	34
Chicago	13	16	14	12	19	14	26
Wisconsin	8	9	13	14	21	26	24
Johns Hopkins	10	10	13	12	12	10	19
Illinois	8	7	16	19	19	18	18
Yale	12	13	13	17	8	16	18
Michigan	2	6	5	2	11	2	13
Cornell	3	8	9	8	19	14	12
Ohio State	2	5	4	13	14	23	11
Harvard	4	5	3	5	18	13	10
Iowa Univ	..	..	..	4	3	6	10

American

James Fitton Couch, "The chemistry of the lupines."

Boston

Burnham Sarle Walker, "A study of renal excretion with special reference to Ambard's laws."

Brown

Laurence Standley Foster, "I. A study of some reactions and properties of the triphenylgermanyl group and its derivatives. II. The conductance of sodium triphenylgermanide in liquid ammonia." Stanley Warren Glass, "I. Oxidation potentials and equilibria in the system: chlorine, iodine, hydrochloric acid, water. II. A study of the system: tellurium, sodium telluride."

California

Arthur Benson Cummins, "The solubility relationships of calcium carbonate, with special reference to the formation of sodium carbonate in soils." Ralph Alexander Morgen, "The free energy of formation of hydrogen fluoride." Oscar Knefler Rice, "Studies in the theory of colloid and surface chemistry." Preston Robinson, "I. Equilibrium in the water gas reaction. II. The free energy of some compounds of tin." Charles Danziger Samuels, "Sulfur oxidation in alkaline soils and its effect on the replaceable bases." William Armand Victor Vietti, "The solubility of lead bromide in aqueous salt solutions: A critical study of the data for the solubility and activity coefficients of difficultly soluble salts in aqueous salt solutions." Richard Wiebe, "The entropies of hydrochloric, hydrobromic and hydroiodic acids from measurements of heat capacities between 15° absolute and their boiling points and heats of vaporization."

California Institute of Technology

Gordon Alles Alles, "The comparative physiological action of some guanidine derivatives." James Byron Friauf, "The crystal structure of magnesium di-zincide. The crystal structure of tetragonal lead monoxide. The design of a cam for an X-ray spectrograph." Sterling Brown Hendricks, "Crystal structure determinations." L. Merle Kirkpatrick, "The crystal structure of sodium periodate. The space-group symmetry of sodium nitrite. The crystal structure of the cubic modification of telluric acid." Charles Holden Prescott, Jr., "The high temperature equilibrium between zirconium oxide and carbon." Oliver Reynolds Wulf, "The thermal decomposition of ozone. Evidence for the existence of activated molecules in a chemical reaction. Possible limits for the heat of dissociation of oxygen." Don M. Yost, "The mechanisms and rates of certain oxidation-reduction reactions in aqueous solution. The existence of trivalent silver."

Catholic

Walter Robert Carmody, "Determination of the electrode potential of lead."

Chicago

Margaret Stella Chaney, "The effect of orange juice on the metabolism of two growing children: I. Calcium, phosphorus, magnesium and nitrogen metabolism. II. Urinary organic acids, ammonia and hydrogen-ion concentration." Kate Daum, "I. The effect of heat upon certain constituents of milk. II. Adult utilization of heated milk." Marietta Eichelberger, "The effect of light on creatinine excretion and basal metabolism." William Gustav Friedemann, "I. The velocity of saponification of methyl formate at 25° C. II. The hydrolysis of sodium cyanide, potassium cyanide, and barium asparaginate at 25° C." Harold Clifford Goldthorpe, "*In vitro* studies on ammonia and urea formation by tissues." Reuben Gilbert Gustavson, "A biochemical study of the female sex hormone." William George Guy, "The radioactivity of the lighter elements." Francis Arthur Jenkins, "The separation of the element chlorine into isotopes (isotopic elements)—the light fraction." Gladys Leavell, "The C_4-saccharinic acids. IV. Further studies in the preparation of 2,3-dihydroxybutyric acid." Israel Morris Levine, "The mercuration of neutral red and its sulfonic acid." Mary Eugenie Maver, "The preparation, rearrangement, and reduction of β-methyldiphenylmethylhydroxylamine." Nicholas Athanasius Milas, "Catalytic oxidation of hydroquinone and quinone by osmium tetroxide and sodium chlorate, and the preparation, properties, and structure of a substance 'Y' tentatively called 2,3-dihydroxydihydro-

p-quinone." Clara Marie de Milt, "Phenylstearic acid." Joseph Wayland Morgan, "Monomolecular and polymolecular films: the structure of thin films of aliphatic and aromatic substances." Thomas Leroy McMeekin, "Studies on the purification of pepsin." Andrew McNally Neff, "The preparation and rearrangement of methyldiphenylmethyldichloroamine." Thomas William Ray, "A study of different methods of preparation of phenylethylmalonic dimethyl ester." Louis Sattler, "The cyclopropane ring. Some factors affecting its stability." Charles Winston Saunders, "The nutritional value of chlorophyll as related to hemoglobin formation." George Edward Spieth, "The C_4-saccharinic acids. V. The preparation of symmetrical dihydroxyisobutyric acid and a study of some of its derivatives." Samuel Bradford Stone, "The atomic weight of chlorine in meteorites and minerals of non-marine origin." Arthur August Sunier, "An attempt to partially separate the isotopes of cadmium." Ruby Kathryn Worner, "The thermal decomposition of chloropentamine chromic chloride." John Demetrius Xanthopoulos, "Rearrangement of stereoisomeric hydrazones." Sybil Woodruff, "The C_4-saccharinic acids. VI. The preparation of the two *dl*-1,2-dihydroxybutyric acids and some of their derivatives." Hoylande Denune Young, "Stereoisomeric bromoiminoketones."

Cincinnati

Jessie Louise Cameron, "A quantitative study of the reducing action of alkali methylates upon aromatic nitro compounds." Robert C. Cantelo, "Equilibria involving carbon and hydrogen." Else Louise Schulze, "The liberation of hydrogen from carbon compounds." Edwin Raymond Theis, "Animal skin fat."

Colorado

Jarvis Moissan Fulmer, "A new series of heterocyclic nitrogenous compounds." Margaret Swisher Klemme, "The nitration of piperonal."

Columbia

John Pape Amsden, "A study of Bredig gold sols." Robert S. Anderson, "The influence of mutameric forms of glucose and of fructose on invertase action." Leslie Victor Braithwaite, "A study of the adsorption of zinc sulfide by copper sulfide in moderately strong acid solutions." Charles Ernest Braun, "Studies on the ultrafiltration and electrodialysis of insulin solutions." Grover Cleveland Chandlee, "A new titration method for the exact determination of phosphorus." Harry Peter Coats, "The hydration of sodium monometaphosphate to sodium pyrophosphate and sodium orthophosphate in alkaline solution at 75°." Jane Elizabeth Dale, "The influence of salts upon the hydrolysis of starch by pancreatic amylase." Stuart Brooks Foster, "The behavior of deaminized collagen." Irving Walter Greenberg, "Further studies in the 'Pechmann dyes' group: the reaction of 'Pechmann dyes' with ammonia and amines and correlated observations." Lilian Elson Harrison, "Solubility and freezing point depression curves of ester–water systems." David Hart, "The reduction of columbic acid and the measurement of the oxidation potential of pentavalent–trivalent–columbium system." Thomas Morley Hill, "Ammonium monometaphosphate and some facts on the chemistry of sodium monometaphosphate." Harold Augustus Iddles, "Separation of the amyloses in some common starches." Chandler D. Ingersoll, "The hydrolysis of sucrose by invertase at high sugar concentrations." Maxwell Karshan, "Biochemical studies of skin and its constituents." Christopher L. Kenny, "A study of the thermostability of vitamin C." Paul Gideon Isaac Lauffer, "Researches in the acridine series; preparation of an isomer of proflavine and of acriflavine." Roy

Francis Layton, "The rôle of electrolyte in the formation of gold sols." Alexander Lehrman, "The solid-liquid temperature relation in the 'ternary system' H_2SO_4–HNO_3–H_2O and its relation to the ternary system N_2O_5–H_2O–SO_3." Leo Lehrman, "The fatty acids in corn starch and synthesis of corn beta-amylose palmitate." Edith Helena MacArthur, "A quantitative study of the determination of vitamin B." Charles Francis Mason, "The activity coefficient of mixtures of electrolytes. The unsymmetrical electric type effect." Merl Harold Meighan, "An investigation of the caustic soda process of extracting low temperature phenols." Ralph Holcombe Müller, "The action of ultra-violet light on certain colloidal dispersions of gold." Willem Anne Nyland, "The effect of the nitrates, chlorides and acetates of barium and calcium on the solubilities of barium and calcium hydroxides." Li Chi Pan, "Insoluble nodes for the electrolysis of brine." Dwight L. Scoles, "I. The replacement of molybdenum by vanadium in ammonium phosphomolybdate. II. A new method for the determination of phosphorus in the presence of vanadium." John Cassius Stauffer, "The nitrogen compounds of Colorado shale oil." Ottomar G. Strieter, "The mechanism of asphalt formation." Earl Keeney Wallace, "The influence of mercuric chloride on invertase action." George Hugh Wallace, "The dissociation pressures of monosodium orthophosphates and of dipotassium and disodium dihydrogen pyrophosphates." Woodford White, "Evidence of the formation of maltose in the early stages of the hydrolysis of starch by amylase." Helen Quincy Woodard, "Bredig and Kohlschutter silver sols as influenced by the presence of certain electrolytes." Zai-Ziang Zee, "The influence of concentration, temperature and humidity on the drying of Chinese lacquer-oil varnishes."

Cornell

Ludwig Frederick Audrieth, "Some new salts of azidodithiocarbonic acid." Harold Ellsworth Goldsmith, "The effect of various carbon pigments upon the rate of oxidation of linseed oil." Robert Charles Houck, "Studies in dyeing." Charles Henry Johnson, "3-Hydroxytetrachlorofluoran, 3,4-dihydroxytetrachlorofluoran, and some of their derivatives." John Calvin Keller, "Overvoltage and catalytic poisons." William Ernest Krauss, "The non-protein nitrogen in certain dairy rations and the partition of nitrogen in the urine produced thereon." Harold Talbot Lacey, "Thymolbenzein, 4-hydroxy-3-isopropyl-6-methylbenzophenone, and some of their derivatives." Russell Cooper Miller, "A study of calcium and phosphorus balances with dairy cattle." Mooljibhai Shivabhai Patel, "A study of the chemical reactions involved in the preparation of oil varnish." Fenton Hendy Swezey, "Some reactions of azido carbon disulfide." Chen Wang, "Pyrogallolbenzein and some of its derivatives." Christopher John Wolz, "Studies in the chemistry of Chinese wood oil."

Fordham

George Bacharach, "Contributions to the comparative study of the nitrating action of metallic nitrates on aromatic organic compounds." Francis W. Powers, "The quantitative determination of phenylacetylglutamine."

George Washington

J. F. T. Berliner, "Studies in vapor pressure and their correlation with the molecular and electronic structure of matter; the isomeric nitroanilines, toluidines and mononitrotoluenes." Frank Porter, "The effect of alpha rays and of light on the interaction of hydrogen and chlorine."

Harvard

Elliott Torrey Adams, "I. The determination of small amounts of calcium. II. Specific dynamic action from the standpoint of the second and third laws of thermodynamics." Albert Harold Blatt, "Diphenylisoxazolone: a study of tautomerism in cyclic compounds." Lucius Williams Elder, Jr., "The indirect electromotive activation of molecular oxygen." Robert Elliott Hussey, "I. The addition of phosphorus trichloride and its phenyl derivatives to unsaturated ketones and quinones. II. The quantitative study of the reactivity of certain organic halides." Curtis Elliott Norton, "Oxidation potentials in liquid ammonia with special reference to free quaternary ammonium radicals." William Ernest Shaefer, "Contributions to the determination of the atomic weight of arsenic." Jacob Bernard Shohan, "The action of acetates on α-bromo-γ-nitroketones." Arthur William Sloan, "The dissociation of substituted dixanthyls." Lyndon Frederick Small, "A study of diaryl alkylmethyls." Julius Frederick Stone, Jr., "The reaction between unsaturated nitro compounds and the Grignard reagent."

Illinois

Ernest Franklin Fiock, "The vapor pressures of alkali metals and alkali halides." Isaac Hahn Godlove, "A spectrophotometric study of certain qualitative color reactions." Floyd David Hager, "A study of the valence of nitrogen in quaternary ammonium compounds." Joseph Allen Harris, "Element number 61 (Illinium)." Glen Sefton Hiers, "I. The catalytic reduction of aromatic amines. II. The synthesis of homologs of dihydrochaulmoogric acid and dihydrohydnocarpic acids containing a cyclohexyl group." William Bultman Holton, "An investigation of rare earth materials for element no. 72." Forrest Everett Kendall, "A crystalline γ-diazo ester of the camphor series." Rob Roy McGregor, "The highly unsaturated fatty acids of menhaden oil." Carl Robert Noller, "I. The use of aliphatic acid anhydrides in the preparation of ketones by the Friedel and Crafts reaction. II. The synthesis of chaulmoogric and hydnocarpic acids." Shripati Venkatesh Puntambeker, "Polyhydroxyanthraquinones—synthesis of refiopin and hydroxyanthrarufin and 1,2,7,8-tetrahydroxyanthraquinone." Charles William Rippie, "The transference numbers of caesium and lithium in mixed chloride solution." Jacob Sacks, "I. The antibacterial action of certain cyclic acids. II. The synthesis of some chaulmoogra derivatives and their anti-bacterial action." Norman McKee Stover, "Fungicidal and bactericidal action of selenium and tellurium compounds." Sherman Israel Strickhouser, "Studies on the relation of the depth of a sprinkling filter to the degree of purification." John Bradshaw Taylor, "Magnetic properties of the alkali metal vapors." Cyprian George Tomecko, "A study of the structure and the synthesis of hydroxystearic acids." William Feagan Tuley, "I. The catalytic reduction of cinnamic aldehyde to cinnamyl alcohol. II. Attempts to synthesize cantharidin." Muppanna C. Tumminkatti, "Studies on the quantitative determination of anthraquinone derivatives in cathartic drugs."

Indiana

Wilbur Elmore Bradt, "A study of seleno-organic compounds and their analysis." Kenneth Wilbert Ray, "The influence of the methods of production upon the properties of high-calcium limes."

Iowa

Jesse Allen Baker, "The solubility of inorganic salts in sulfur monochloride with certain types of inorganic salts." Edward Joseph Barta, "Studies in the utilization of

Steffens waste." James Canfield Colbert, "The effect of substituents in the formation and reactions of certain ethers." Hugh Leslie Davis, "Condensation products of benzol-acetophenone and some of its derivatives." George Carroll Hilman, "New derivatives of vanillin and some of their reactions." Martin Josiah McHenry, "A simple and rapid electrometric method without the hydrogen electrode, for titrations involving (1) total acidity or total basicity; (2) alkaloids." Ben H. Peterson, "Some physical properties of alum floc." William Ralph Skidmore, "Some reactions of sulfur and its oxides." Samuel Riley Spencer, "The conductivity of lithium nitrate in methyl and ethyl alcohols and in water and in mixtures of these solvents." Emma Louise Wardell, "The influence of the ingestion of methylated purines on the excretion of uric acid."

Iowa State

Chester Elgin Adams, "I. Organic oxygen antiseptics. II. The constitution of aliphatic diazo compounds. III. Anti-knock compounds." Nathaniel John Beaber, "I. The electronic interpretation of reaction applied to halogen organic compounds. II. A study of antiknock compounds." George Hendrie Brodie, "The heat of formation of iron carbide as electrolyzed in a pure iron carbon alloy of eutectoid structure and composition." James Austin Burrows, "The spontaneous decomposition of potassium chlorate." Jesse J. Canfield, "The equilibrium attained for the system hydrogen–bromine vapor and hydrogen bromide under the influence of the corona discharge." Werner W. Duecker, "The influence of temperature and time on the swelling of gluten in solutions of various acids." Harry Parker Evans, "The graphitizing behavior of iron carbide in pure carbon alloy for the temperature interval 700° C. to 1100° C."

Johns Hopkins

Paul William Bachman, "Adsorption on surfaces of mercury." Owens Hand Browne, "Reactions of lead tetraethyl." James Earl Copenhaver, "*m*-Diethylbenzene and some of its derivatives." Lillian Crombie Burroughs Davis, "Disposal of dairy wastes." Alfred Willis Dearing, "Reactions of ethyl orthosilicate." Winthrop Bulkley Dillingham, "I. S-Triethylbenzene and its derivatives. II. The effect of silica gel on sulfur in gasoline." Dorothy Getz, "I. A study of the decomposition of nitrogen pentoxide. II. A study of some volumetric standards." Cecil Jerome Haggerty, "Studies in the electrical properties of silver solutions." Ariston Jacusalem Hermano, "A comparative study of starches." Hui Hsieh, "Studies in the abnormal viscosities of lyophile colloids." Mary Lydston Kilpatrick, "The catalytic action of dust." Harry Dayton Kruse, "Chemical studies on the vitamin B." Oscar William Lusby, "Studies in catalysis." Orland Merrece Reiff, "Thermal decomposition of hydrogen peroxide." J. Leon Sheroshefsky, "Study of the vapor pressures in small capillaries." Sherlock Swann, Jr., "Oxidation of heavy hydrocarbons at high pressure temperature and high pressure." Francis Marion Walters, "Effects of carbon monoxide poisoning upon metabolism." Herbert Finis Weide, "A new experimental method for the study of gaseous effusion." Lois Emily Witham, "Some studies on the chemical nature of vitamin B and a comparative study of the vitamin B requirements of rats and pigeons."

Kansas

A. A. Groening, "Decomposition voltages and metal overvoltages in liquid ammonia and in water."

Maryland

H. S. Isbell, "The chemistry of gold carbon compounds." D. C. Lichtenwalner, "Heat changes accompanying adsorption equilibria in solution." E. B. Starkey, "A test of the theory of partial polarity; the addition of halogen acids to double bonds in inert solvents." C. E. White, "The effect of the presence of phosphates on the adsorption of acid dyes by mordants."

Massachusetts Institute of Technology

Alan Emerson Cameron, "The effects of arsenic on steel." Thomas Garfield Chapman, "An investigation of the principles of sulphatizing roasting of cupric oxide." Frances Hurd Clark, "A study of the relation of heat treatment, microstructure and hardness of 60:40 brass." Frank Cortese, "The influence of structure on the reactivity of the hydroxyl hydrogen in alcohols." John Arthur Gibson, Jr., "Heats of dilution with a continuous flow calorimeter." Emil Durbin Ries, "The thermal characteristics of Seger cones. A reaction rate study of the contact sulfuric acid process." Cyril Stanley Smith, "Action of hydrogen on solid copper." Chao-Lun Tseng, "On the systematic use of selected series of derivatives in the specific characterization of alcohols, phenols, amines and mercaptans."

Michigan

Werner Emmanuel Bachmann, "The reducing action of a mixture of magnesium iodide (or bromide) and magnesium on aromatic ketones: probable formation of magnesium monoiodide (or bromide)." Egbert King Bacon, "Diffusion potential studies: their application to the systems hydrochloric acid–sodium chloride; hydrochloric acid–gelatin and a new method for the determination of the equivalent weight of gelatin." William LaVilla Fink, "Influence of heat treatment and carbon content on the structure of pure iron carbon alloys, as shown by metallographic and X-ray methods." Clifford Cook Furnas, "A new method for the determination of thermal properties of solids with application of data to the thermodynamics of the blast furnace." Arthur John Good, "A study of the equilibrium vaporization of crude petroleum and a comparison of two methods of vaporization." Seiichi Izume, "Studies on the influence of hydrazine, substituted hydrazines and related nitrogenous compounds on the carbohydrate metabolism in the rabbit." James Lyle Kassner, "A study of lead perchlorate and its use in analytical separations." George Hamilton Montillon, "A study of continuous crystallization from aqueous solutions." Lawrence August Philipp, "The transfer of heat from metal to boiling liquids with forced convection." Edward Harner Potthoff, "A study of the important variables influencing the cracking of petroleum oils." Alfred William Schluchter, "Electromotive force measurements applied to the determination of transference numbers of sodium hydroxide solutions and to a study of the nature of the reaction between sodium hydroxide and gelatin." Harvey McCormick Trimble, "The relation of escaping tendency to particle size." George Benson Watkins, "Gaseous explosions: the rate of rise of pressure of pure fuels in homogeneous gaseous explosions under constant initial conditions."

Minnesota

Hervey Hubbard Barber, "Separation of the copper-arsenic group with especial reference to the degree of solubility of certain sulfides." Forrest Ramon Davison, "The pectic enzymes." Ralph Lewis Dowdell, "Study of the decomposition of the austenitic structure in hardened steels." Emily Helene Grewe, "Glutenin in its rela-

tion to flour strength." J. Roy Haag, "The antagonism of mineral ions in animal nutrition." Vlon Neilan Morris, "The catalytic activity of metallized silica gels. I. Hydrogenation reactions." Lloyd Edward Swearingen, "The adsorptive properties of metallized silica gels and their catalytic activity in some simple oxidation reactions." Carl George Vinson, "Some nitrogenous constituents of corn pollen."

Missouri

Harold McCloskey Harshaw, "A study of the nutrients required by mammals for successful reproduction."

Nebraska

Frederick Wilhelm Jensen, "The oxidation of *d*-glucose in sodium carbonate solution in the presence of copper."

New York University

Roy Richard Denslow, "The thermal decomposition of nitrosyl chloride." Waclaw Andrew Wesolowski, "The gaseous reaction between hydrogen sulfide and sulfur dioxide."

North Carolina

Frederick Philips Brooks, "The nitration of 2-amino-*p*-cymene." Horace Downs Crockford, "Heat of fusion of some nitrotoluenes." Charles Roberts Harris, "2,6-Nitroamino-*p*-cymene and certain new azo dyes." Earle DeWitt Jennings, "I. Study of gossypol. II. The bromination products of cymene." Sihon Cicero Ogburn, Jr., "The analytical reactions and a scheme of separation of the platinum metals."

Northwestern

Edwin Lysle Gustus, "Dissociation in the methylated sugars."

Ohio State

Marjorie Pickard Benoy, "The action of alkaline oxidizing agents on the disaccharides." Robin Charles Burrell, "The effect of certain deficiencies on the nitrogen metabolism of plants." Albert Mitchell Clifford, "The action of sulfur on certain aldehyde-amine condensation products and the value of the substances as accelerators in the vulcanization of rubber." Theodore Sheldon Eckert, "Rate of crystal growth." Bernard Harold Gilmore, "Determinations of the average cross-sectional areas of molecules in the terpene and camphor groups." George Melvin Karns, "A determination of the size and probable shape of several organic molecules." Otto McCreary, "The influence of lactose on deterioration of milk powder." William Whistler Mills, "A precision study of iodine as a standard substance in chemical measurements. II." Raymond Eugene Schaad, "A study of the action of knock suppressing and knock inducing substances upon the combustion of certain pure fuels." Siong Ceh Sung, "The constitution of the Grignard reagents and the mechanism of their condensation reactions." Lloyd Clayton Swallen, "A study of the preparation and properties of β-halogen aliphatic substituted ethers."

Pennsylvania

Gosta Akerlof, "Investigations on sulfate solutions." Harry A. Alsentzer, "Complexes containing cobalt, molybdenum and tungsten." Mary Adelia Bennett, "Studies

on hemorrhage." Stuart Dunshee Douglas, "Activity coefficients of the alkali halides." Geoffrey Minto James, "Electromotive force studies of the alkaline bromides and the dissociation of water in sodium and potassium bromide solutions." Stanley Elphinstone Kerr, "Studies on the inorganic composition of blood." Wallace Morgan McNabb, "An accurate method for the determination of phosphorus pentoxide as magnesium ammonium phosphate."

Pittsburgh

Carlton W. Croco, "Electrochemical chlorination and bromination of benzene." Sidney H. Katz, "Development and characteristics of carbon monoxide recorder." Jacob Nevyas, "The electrochemical reduction of indigo."

Princeton

Boris Bruzs, "Velocity of thermal decomposition of carbonates." Ralph Thomas Halstead, "The constitution of the alloys Al-Mg from 32 to 48 per cent Mg." Frank Brian Root, "The rearrangement of hydroxamic acids isomeric with triphenylacethydroxamic acid." William Walker Russell, "The promoter action of thoria on nickel catalysts."

Stanford

Ruth Vivia Fulton, "Metallic salts of the carboxyazyllic acids." Oliver Wolcott Johnson, "The uniform movement of flame in mixtures of ethyl alcohol vapor and air." Kenneth Keith Kelley, "A test of the third law of thermodynamics in the case of an organic reaction." Kenneth Sinclair Ritchie, "An improved spectro-colorimeter and color studies of ferric chloride solutions." Francis Albert Smith, "Conductance of acids and salts in liquid ammonia."

Virginia

Raymond Brandenburg Purdum, "I. A study of the catalytic conversion of benzene to cyclohexane. II. Equilibrium in the system benzene–hydrogen–cyclohexane. III. Velocity measurements in the presence of metallic copper at 200° and 240°." Leland A. Stewart, "The catalytic combination of ethylene and hydrogen in the presence of metallic catalysts."

Wisconsin

Grover Leroy Corley, "The study of the electrolytic reduction of nitrates." Sheldon James Dickinson, "A study of the action of selenium oxychloride on benzene and toluene." Samuel Morris Gordon, "Studies in the biogenesis of the mints." Walter Henry Hartung, "The constitution of aldehydes in relation to affinity and reactivity in acetal formation." Ellery Hale Harvey, "A study of sulfur chlorides and their reactions with various fatty oils." James Karr Hunt, "A study of the chemical effects of electronic and ionic impacts in oxygen." Glenn Llewellyn Jenkins, "*Datura stramonium*, a pharmaceutical study." Chung-Hsi Kao, "The separation of selenium and tellurium and the chemistry of selenium monochloride." Villiers Willson Meloche, "A study of telluric acid, allotelluric acid, and potassium tellurate." Philip Thompson Newsome, "A study of the influence of the electrodes on chemical reactions produced in the electric discharge." Merle Starr Nichols, "Studies on the metabolism of *Coryne-*

bacterium diphtheriae." Harvey Day Royce, "The electrode potential and replacing power of manganese and a study of some of its alloys." Peter Pen Tieh Sah, "The preparation of ortho-esters and their condensation with acetoacetic ester and malonic ester." Oliver Henry Schunk, "A study of the sensitivity of the silver halide grain in photographic emulsions." Alfred Joaquin Stamm, "An experimental study of emulsification on the basis of distribution of size of particles." Warren Kidwell Stratman-Thomas, "On the chemotherapy of neurosyphilis and trypanosomiasis." John Northcott Street, "Influence of beta substitution in the alcohol on reactivity and affinity in acetal formation." Carl Errett Swartz, "A study of the formation and decomposition of zinc ferrite." Ralph Newton Traxler, "The osmotic permeability of plant membranes." Patrocinio Valenzuela, "A pharmaceutical and phytochemical study." Waldemar Vanselow, "The photochemical decomposition of nitrogen pentoxide as related to the Einstein photochemical equivalence law." Marion Henry Veazey, "Studies in the cataphoresis of gelatin systems." James Waddell, "Iron in nutrition." Leon Stevens Ward, "The influence of gelatin on the coagulation of ferric oxide sol by electrolytes."

Yale

John Arthur Anderson, "An application of the electrolytic method for the separation of α-amino acids in proteins." Rossleene Merle Arnold, "An experimental study of the lymph of the dog: its composition and relation to the blood and tissues." Herman Albert Beekhuis, Jr., "Utilization of low-temperature tar." Fayette Dudley Chittenden, "Extraction in liquid-liquid systems." Floyd Shelton Daft, "A study of the protein constituents of sericin." Harold Glenn Dietrich, "Equilibrium between crystalline zinc hydroxide and aqueous solutions of ammonium hydroxide and of sodium hydroxide." Raymond Norris Evans, "The directive effect of the phenol group in the preparation of ketone derivatives of β-naphthol." George Lewis Frear, "The solubility of calcite in solutions of calcium sulfate and of sodium chloride." Donald McKinley Hetler, "A chemical study of *Bacterium Aerogenes.*" Edwin Patterson Jones, "The mutual solubility of some disubstituted derivatives of benzene." Norman William Krase, "Improvements in the manufacture of nitric acid from ammonia." Helen Geneva Leopold, "The vapor pressure of a number of saturated aqueous salt solutions." Harold Levine, "Some effects of unusual diets upon growth, exercise, and metabolism, with special reference to ketosis in the rat." Harry Gustave Lindwall, "Some new derivatives of oxindole." Mary Clarissa McKee, "Some nitrogenous constituents of the cauliflower." George Albert Williams, "A study of the laxative action of wheat bran." Jet Corine Winters, "The effects of dietary deficiencies on the growth of certain body systems and organs." Mildred Ruth Zeigler, "An investigation of the excretion of organic dyes: a study of membrane permeability."

Helium Found in Ontario. A widening of the field of production of helium gas to include the Canadian province of Ontario has been recently announced. The Ontario government claims that a deposit of helium gas has been discovered at Inglewood, about 40 miles from Toronto. Three wells have been taken over by the government and are being worked. Commercial development of helium gas on a large scale is expected to result in time. The discovery was made during the war but was kept a secret until recently when the wells were taken over by the government.—*Science Service*

A RESEARCH INSTITUTE FOR CHEMICAL EDUCATION

The multitude and variety of problems which have been presented at the first meetings of the Senate of Chemical Education make it evident that some scientific research in chemical education is imperative if the problems in this field are to receive a scientific solution comparable with their importance in the development of our science. In view of these facts the major problem to come before the A. C. S. Senate of Chemical Education at the Richmond meeting of the Society, April 11th–16th, is a definite plan for a Research Institute of Chemical Education. A tentative plan has already been placed before the members of the Senate but the Senators are desirous of having comments, suggestions, and frank criticisms from the readers of the JOURNAL before any definite plans are formulated. Hence the tentative plan is being published as worked out at the Philadelphia meeting of the Society.

Purpose of the Institute

The object of the Institute should be to conduct, assist, and encourage investigation in chemical education and to make knowledge related thereto available for the teachers of chemistry.

Chemical education must follow the trend of our science, and hence it should not be the aim of the Institute to perpetuate any lines of investigation or any of its own departments should the usefulness or promise of these at any time become doubtful either from changes in our science or from lack of leaders of vision or achievement. On the other hand, in order that each problem may receive proper support and attention, no time limit should be set upon any project. Such an organization would make the work adjustable to an ever-changing science.

Location

The Institute should be located at some university which is doing work of a high order in both chemistry and education, but should be organized separately from either of these divisions.

Administration

The charter should provide for a board of seven trustees, a board of seven scientific advisors, a general director, associate directors to head the departments, and research assistants adequate for the work to be undertaken.

There should be five departments: (1) Graduate; (2) undergraduate; (3) industrial; (4) high-school; (5) historical.

Organization

The board of trustees should be appointed by the donor or donors; the board of scientific advisors by the Senate of Chemical Education; the general director by the board of trustees; the associate directors and research assistants by the same board of trustees on recommendation of the general director. The directors of the board of scientific advisors and at least three of the board of trustees should be members of the A. C. S. The board of trustees should include two representatives of the board of scientific directors. The general director should be an ex-officio member of both boards.

The board of trustees should have charge of all finances, while the board of scientific advisors should help determine what problems should be investigated in the Institute and advise in their solution. There should be a budget committee, consisting of three members of the board of scientific advisors and two members of the board of trustees, to prepare budgets for the different projects.

Graduate Department

The Graduate Department should be headed by a man with a comprehensive grasp of the fundamentals in all phases of chemistry and the ability to weave them into a coherent whole. Arrhenius did such a piece of work in the formulation of his ionization theory. At the present time theories concerning the structure of matter need to be brought together in such a way as to explain all our fundamental concepts. Had a department of the proposed type existed this would undoubtedly have been done and brought into the teaching field years ago. Teachers either do not have, or do not take the time to search the literature and incorporate the newer theories in their courses. Consequently, developments on the research frontier find their way into the class-room only by a slow process of infiltration. Such a department would perform a task of the utmost importance to the advancement of our science.

Industrial Department

1. The Industrial Department should be headed by one of our greatest industrial men—a man who has a general knowledge of all the leading industries and is able to see the parts which should be placed in our industrial chemistry curricula, and the parts which should be woven in by way of applications in our different chemistry courses.

2. There should be miniature model industrial plants where the teachers could have a chance to get an idea of the working of all the leading industries and the various steps in the different processes by making a visit to the Institute. The potentialities of this phase of the

department are readily apparent to anyone who has visited industrial exhibits.

3. Plans should be developed and promoted for bringing about a closer coöperation between the industries and universities.

4. Plans should be worked out for keeping industrial men in constant training.

5. Chemical engineering education should be given more attention.

College Department

Opinions in chemical education, like theories in the science itself, must be subjected to experimental examination if we are to insure progress in our educational work. This department would carry out experiments to determine:

(1) The most efficient methods and apparatus for presenting new material recommended by the graduate and industrial departments.

(2) The place and time for different methods of instruction, such as visual, experimental, lecture, etc.

(3) Whether pandemic chemistry has a place in our college curriculum and, if so, what material it should include.

(4) Whether professional and liberal arts students should have different freshman courses.

(5) Whether colleges should have a different freshman course in chemistry for each profession (dentistry, pharmacy, etc.).

(6) The practices of chemical education in foreign countries which are applicable to our own problems.

(7) What are the educational values of note-book work and how these may be most efficiently accomplished.

(8) The correlation of high-school and college chemistry.

(9) The quality and quantity of a college teacher's qualifications.

(10) The correlation of chemistry with the other science courses in the college.

High-School Department

The High-School Department would take up many of the same problems as would the colleges, but from a high-school standpoint. All the problems listed under College Department should be taken up by the high school with the exception of (5).

Historical Department

There are few, if any, universities or other agencies in the United States that are committed to the promotion of research in the history of chemistry. One has only to step into Dr. Smith's office[1] to appreciate what

[1] Cf. THIS JOURNAL, 3, 563 (May, 1926).

could be done by an Historical Department. Many of the problems in this department would be large enough for doctorate dissertations. They could be made comparable with any dissertation put out by a history department. In addition this department would be able to furnish an historical exhibit which would be worthy of a visit from any teacher in the remotest part of the United States.

Finance and Its Distribution

The total finance required would be $2,000,000. This would be divided as follows:

Building and permanent equipment (furnished by the University)	$ 500,000
Endowment (furnished by donor or donors)	1,500,000
	$2,000,000

Distribution of Income from Endowment:

Estimated income from $1,500,000		$75,000
Salary of general director	$10,000	
Salary of graduate director	10,000	
Salary of industrial director	10,000	
Salary of college director	10,000	
Salary of high-school director	10,000	
Salary of historical director	10,000	
Five fellows (at $1,000 each)	5,000	
Extra summer faculty lectures	5,000	
New equipment each year	5,000	
Total	$75,000	

Obligations and Privileges in Coöperative Plan

1. The University is to furnish:

A building of which the cost (including permanent equipment) will be $500,000. It is to keep the building and its permanent equipment in good repair and furnish light, heat, and janitor service.

The Institute may be removed from the coöperating university by a majority vote of the Board of Trustees of the University or by a like action on the part of the Board of Trustees of the Institute. In such a case the building and permanent equipment would become the property of the coöperating university while all movable equipment would become the property of the Institute.

The five research fellows would be exempted from tuition and laboratory fees, but the university would be entitled to all other tuition fees from any other students attending the Institute.

Instruction

Although the five departments of the Institute would be organized for research only, under normal conditions each Associate Director would give one course which should include the latest developments in chemical education in his particular field. The directors should devote the remainder of their time and energy to research in their particular fields.

The research in the respective departments should be carried on independently, yet it should be the aim, through coördination and coöperation, to make them mutually helpful.

Registration

Applications for registration in the Institute would be received in the same manner as applications to take any other course at the University, and fees comparable with those for other courses of the University would be charged for courses in the Institute. All fees of this nature would go to the University.

The qualification for registration in the Institute would include a B.S. degree in chemistry or its equivalent and this work should be supplemented by one standard course in psychology and one in educational psychology.

Summer Work

Extra curricula would be provided during the summer in order that the Institute might be of greatest service to the greatest number of teachers. Some of the most outstanding men, both in chemical education and in the pure science itself, should be obtained for the summer work. It should be made the great meeting place for the chemistry teachers of the world, where the teachers will have the opportunity not only to brush elbows with their fellow workers but to listen to chemistry teachers of national and international reputation. The Institute should be the Mecca for all those who are interested in chemical education.

Criticisms and suggestions on the foregoing plan are sincerely requested.

THE SENATE OF CHEMICAL EDUCATION,
Neil E. Gordon, *Chairman*,
University of Maryland,
College Park, Md.

Chemical Digest

WHY EDUCATION?

What are the motives of education? Perhaps the first motive in the lives of many is that of making more money, which is emphasized in the vocational training schools of today. O. Herschel Folger, in a recent paper,[1] says:

> There is a subconscious though unconfessed idea in the minds of many that it is better to raise better sheep and more cotton than to know about wool tariff and economics. However the extremes of attitude may have been, there is some justification for the numerous statistics displayed which show that extended schooling increases the possibilities for financial success and for progress in one's chosen vocation.
>
> A second motive that would seldom be admitted by one possessing it, is illustrated by the college freshman who gave as his reason for going to college that he could then be admitted to membership in the university club. This motive is touched upon by the woman in Maine who thought a speaker was educated because he "used words a mile long" which she could not understand, by the man who wanted his daughter to give him the "algebra" for cabbage, and by the man who is in search of degrees, conferred or acquired. This motive goes by various names, of which the most dignified is prestige. It has its ridiculous side, closely connected with the idea that "finishing schools" "finish" with commencement, but it also has its better side, for it no doubt arises out of a desire to "walk circumspectly, not as fools, but as wise," and it has its most beneficial influence in raising the standards of schools in order that their diplomas might have a greater influence.

Another motive which Mr. Folger mentions is that of training for citizenship which is one of the steps in changing a melting-pot into a republic of intelligent citizens. He further writes:

> But any motive listed in connection with education is sure to be based, directly or indirectly, upon the mind and its processes. Though many of the old prescribed courses simply for mental training have been made elective, the present interest in psychological effects counterbalances that change. Perhaps the thinking motive for the individual is weak. Someone has quoted a woman scrubbing clothes, who may have been typical though optimistic, when she said: "Well, I'm glad I ain't one o' them college professors, having to use their brains every day." Sir Joshua Reynolds said, "There is no expedient to which men will not resort to avoid the necessity of thinking." Edison has said that the affairs of the world are controlled by a few men who think. The need of the thinking motive was contrasted with the one of so-called success by "The Yale Saturday Evening Post" in recent years: "We believe that Yale is preparing men not to live but to make a living; that the life of the undergraduate is stupid, empty and meaningless. . . . . Universities are enlarged, not to encourage thought,

[1] "Education? Why?" *Educ.*, **47**, 233–41 (Dec., 1926).

but to ladle out information like soup in a cafeteria. A new point of view, a new thinking attitude, a philosophy of life is needed."

At about the same time, "La Critique," at Dartmouth, made another contrast: "We believe that Dartmouth is graduating each year about three hundred Babbitts to go forth and exploit others for the good of themselves alone, to become loyal Americans and never think." Thus representatives of the student bodies of two of our most prominent universities declare that there is danger of two motives discussed above—vocation and citizenship—because they may easily crowd out the more important motive of mental development.

Appreciation is listed as a motive for education which will make easier the accomplishment of another element and is part of another motive: to learn the art of living together. Quoting further from the same article:

Living together, after all, depends upon character, and character our education should build. Otherwise it is dangerous. Froude said: "We are all selfish; the sage is no better than the fool, and only more dangerous." "Even divine philosophy may push beyond her mark and be procuress of the lords of hell," and Loeb and Leopold were only more glaring examples than others of what education may do without character building. Huxley gave as the object of education: To harmonize the mind and body, to make the intellect a clear, cold logic engine, to train the passions to come to heel by a vigorous will, the servant of a tender conscience, and to learn to love all beauty, whether nature or art, to hate all vileness and to respect others as oneself.

Ruskin's belief was that education means teaching people to behave as they ought to behave. "It is not teaching youth the shapes of letters and the tricks of numbers, and then leaving them to turn their arithmetic to roguery and their literature to lust. It means, on the contrary, training them into the perfect exercise and kingly continence of their bodies and souls. It is a painful and continual and difficult work, to be done by kindness, by watching, by precept and by praise, but, above all, by example." However educators may differ as to method, it must be admitted that an education that does not include character building is incomplete.

The late President Eliot, in describing the college, summarized many of the motives in education, with character-building at its climax: "Here may young feet, shunning the sordid paths of low desire and wordly ambition, walk humbly in the steps of the illustrious dead—the poets, artists, philosophers, and statesmen of the past; here may fresh minds explore new fields and increase the sum of knowledge; here from time to time may great men be trained up to be leaders of the people; here may irradiating light of genius sometimes flash out to rejoice mankind; above all, here may many generations of manly youth learn righteousness."

The author concludes his article by saying:

Thus the fullest education rests upon many motives; in the ideal none can be eliminated, regardless of the rapidity of change in technic. True, attempting to hold to all of them, especially the extremely difficult ideals of character and religion, will create a tremendous task for any educator. But the greater the task the greater the opportunity and the greater the joy when a vision of the ultimate influence is seen.

W. R. W.

SCIENTIFIC PROGRESS IN EDUCATION

In an address delivered on the occasion of the fiftieth anniversary celebration conference of the Johns Hopkins University in October, Dr. William H. Burnham[1] outlined some of the advances in educational doctrine during the past fifty years which suggest future possibilities. The general recognition of the fundamental truth that the education of an individual comes not by the acquisition of knowledge divorced from action is the first mentioned. Regarding this he writes:

> The great maxim of modern reform in education is the activity of the pupil instead of the didactics of the teacher. There are but two methods of instruction: as regards the pupil, the active and the passive; as regards the teacher, the method of demonstration and the method of suggestion. The active method has been most completely adopted in the kindergarten occupations, in manual training, in the laboratory and in research at the university. The teacher suggests; the pupils act. The teacher's business is not demonstration but guidance. The project method, the Dalton plan and perhaps a score of other methods, aim to give the child his inalienable right, namely, a task of his own.

A second step in educational progress is the recognition of healthful physical development as the prime condition of a sound education. Dr. Burnham says:

> The objective that mental hygiene emphasizes and to which education is slowly progressing, is the development by thorough training of a few essentials of individual mind and character: an integrated personality and the concentration of attention implied by this; a few wholesome mental attitudes and interests giving control and perspective; freedom from fear, egoism, jealousy, and other childish attitudes; an intelligent altruism and the ability to coöperate in any social group.
>
> The imperative need of these attitudes is clear from the tragic cases so frequent among those who lack them—those who drift into sanitariums to be reëducated. The school of tomorrow will aim to develop the habits of mental health, to prevent the need of reëducation in the hospital.

The complexity of education may also be mentioned as a definite advance. Regarding this we quote the following:

> In the old days it was a simple thing to describe the kinds of education that were good and to point out the kinds that were bad, and to say, cherish the former, renounce the latter; but today a thousand kinds of education are good. It is not a question of what is good and what is bad but of what is good and what is better, and of finding methods by which we can sacrifice the good for what is better. It is a question also of social and educational relativity. Some, like Trigant Burrow, maintain that the principle of relativity is as important in education as in astronomy. No wonder there is confusion of aims and methods both in this country and in Europe. Hence the need of individual study of children and of individual adjustment, hence the need of social adjustment, and everywhere the need of an intelligent ignorance.

[1] "Scientific Progress in Education in the Last Fifty Years," *Sch. and Soc.*, **24**, 741–6 (Dec. 18, 1926).

A fourth advance is the development of the democratic ideal in education. Dr. Burnham writes:

> In its old form the democratic ideal in education rested on the childlike assumption that all men are equal. The higher modern form of the ideal rests on the psychological fact of profound individual differences. The ideal democratic group today is one where each member of the group has the opportunity to become superior in something according to his special ability, and where the leader does not dominate the group but merely coördinates the different superior abilities for the common purpose of group welfare; or, to put it more simply, in the words attributed to the great Pasteur, a group where each has opportunity for initiative for the public welfare—not a theoretical vagary, but illustrated in the amateur game of baseball on a million playgrounds.
>
> While today the literary pastime of many social and political writers seems to be to show the failure of democracy in politics and society, to speak of the failure of this higher form of the democratic ideal in education is absurd; for this ideal we have never really tried. Distinct advance, however, is shown in educational doctrine here because this newer democratic ideal rests on a sound psychological basis and presents an inspiring ideal both for the schools and for society.

The recognition that the higher results of learning are worthwhile for their own sake may be taken as another step in this progress. We quote the following paragraphs in connection with this:

> Fifty years ago this autotelic aim of education had scarcely been mentioned, except by Emerson. It was a vagary of philosophers. Everywhere education was extolled because of the advantages it ensured. Today the ideal of education for its own sake has been made plain by Dewey and others; and in practice it is made clear by the few who prize educational opportunity more than salary and emolument. The best universities have begun to foster this by their emphasis now placed on higher education and research apart from utilitarian and material value.
>
> Today fortunately most colleges and universities perhaps have washed their diplomas free from all formal traces of immunity stain; but there remain more or less in conflict, on the one hand the ideal of accomplishment, on the other the objective of credits and degrees. Any institution that desires to be truly educational will strive to minimize as much as possible all immunity incentives and to multiply and increase as much as possible all opportunities for real scholarly and scientific achievement.

Of the sixth step Dr. Burnham writes:

> Thus a sixth step in educational progress, vastly significant, is the recognition and use of the scientific method in educational problems. In mental measurements, in the application of quantitative methods to various problems in relation to scholarship and the results of different methods and different conditions of learning, and to problems of administration, a beginning in scientific investigation of the greatest importance has been made. While it is true the results of such methods have often been interpreted unscientifically; while it is true that the use of quantitative standards and the like has often unfortunately turned the attention of teachers unduly to the scholastic product and away from the essential things, the mental processes involved in learning; nevertheless this movement has been significant as a recognition of the importance of the scientific method in education.

W. R. W.

SCIENTIFIC EVENTS OF 1926

The year just past was marked by notable advances in all fields of science and research. *Science Service* lists the following among the highlights of chemical achievement:

It was claimed that hydrogen was transmuted into helium by Prof. F. Paneth and Dr. Peters, of Berlin University.

Gold was claimed to have been transmuted to mercury by Dr. A. Gaschler, of the Berlin Technical High School.

Nitrogen is changed to fluorine and then to hydrogen and oxygen when hit by the nucleus of an atom of helium, Dr. William D. Harkins, of the University of Chicago, told the National Academy of Sciences.

Prof. B. S. Hopkins, of the University of Illinois, discovered a new chemical element, No. 61 in the periodic table, and named it illinium.

Elements 75 and 43, reported discovered by Prof. Walter Noddack of Berlin in 1925, have been relegated to the limbo of still undiscovered metals by experiments at the Platinum Institute of the Russian Academy of Sciences which failed to substantiate the German results.

A synthetic drug called plasmochin, more powerful than quinine, was made in the Elberfelder Farbenfabriken.

Compounds analogous to chaulmoogra oil were made in the laboratory by Dr. Roger Adams, of the University of Illinois, and were found to act as an effective germicide against leprosy.

The valuable constituent of insulin was prepared in crystalline form by Dr. John J. Abel, of Johns Hopkins University.

The first enzyme, one of an important class of substances involved in digestion, to be isolated was made in a crystallized form by Dr. James E. Sumner at Cornell University Medical School.

An extract of the parathyroid gland, which controls the lime content of the blood, was prepared successfully from animal glands by A. M. Hjort and H. B. North, Detroit chemists.

Luminous flames radiate more heat than non-luminous flames, according to tests made by Prof. R. T. Haslam and M. W. Boyer, of the Massachusetts Institute of Technology.

A new method of welding pieces of metal together was announced by Dr. Irving Langmuir, of the General Electric Company, by which hydrogen molecules are broken into atoms and recombined to give an intensely hot flame.

Methods for liquefying coal and obtaining motor fuel and other valuable products from coal were perfected by Dr. Friedrich Bergius and Dr. Franz Fischer, both Germans, and General Georges Patart, of Paris.

A process for making sugar from wood was developed by Prof. Friedrich Bergius, of Heidelberg University.

Tests made by government chemists showed that a thin film of metallic chromium electroplated upon printing plates of finished steel or copper-nickel would make the plates wear longer than plates of hardest steel.

A world famine in rubber by 1930 was predicted by the U. S. Department of Commerce.

Commercial application of carbon dioxide ice for refrigeration purposes has reached the practical stage.

The widespread supplanting of cotton by rayon and similar fabrics made from wood began a revolution in American agriculture.

A project was set on foot to produce levulose sugar in large quantities from the roots of dahlias.

A system of zoning was evolved at the International Conference on Oil Pollution in an attempt to solve the problems arising from the discharge of waste oil by vessels at sea.

A set of world standards for gasoline and other liquid fuels was proposed at the meeting of the International Union of Pure and Applied Chemistry.

Prof. Richard Zsigmondy of the University of Goettingen, Germany, received the 1925 Nobel prize for chemistry, and Prof. The Svedberg of the University of Upsala, Sweden, was awarded the 1926 Nobel chemistry prize.

Poland elected as its President, Prof. Ignatz Moscicki, well-known scientist in the field of chemical engineering.

The American Chemical Society celebrated the fiftieth anniversary of its foundation.

A meeting of the International Union of Pure and Applied Chemistry was held at Washington, Sept. 13th–15th.

Jelly Essence Makes Mayonnaise Stand Up. How lemon pectin, the new concentrated essence of jelly, is coming to the aid of commercial mayonnaise dressing was told by C. P. Wilson, citrus by-products expert of Corona, Calif.

Home-made mayonnaise, consisting of salad oil, egg, and seasoning, is a highly approved food, but will not "stand up" long enough to survive the delays of commercial storage. The oil globules, normally highly dispersed as a fine smooth emulsion in the egg medium, get together and run away, on account of the inadequate power of the egg to keep them where they belong.

Lemon pectin, a colloid substance now being made in large quantities from the white "rag" of lemon peel, is found to be just the ingredient needed to stiffen up the eggs and make the salad-dressing emulsion permanent. The old-time standard dressing, containing no pectin, is rendered unstable by the presence of salt and vegetable acids, both of which are required by the demands of taste. The addition of the jelly principle leaves the mayonnaise manufacturer free to devise the most appetizing product possible. Being itself a carbohydrate food, the pectin is by no means to be classed as an adulterant.

Orginally developed as a jelly-maker, lemon pectin still has a large market as such, but late figures predict that the mayonnaise trade may soon overshadow the original application entirely.—*Science Service*

ABSTRACTS

The Gasoline Situation. ANON. *Can. Chem. & Met.*, **10**, 217 (Sept., 1926).—In discussing the gasoline situation, H. H. Hill, Chief Petroleum Engineer of the Bureau of Mines, states that of the 25,000,000 automobiles in use in the world over 80 per cent are in the United States, or one for every six people. In 1925 the petroleum production was 2,000,000 barrels per day, the same as the entire production during the year 1900. Since 1915 the gasoline production has increased 429 per cent, so that the daily gasoline production is now 30,000,000 gallons. At present it is estimated that 60–80 per cent of the oil present in the sand is not recovered but by use of compressed air or gas, water flooding, or the introduction of some new method the waste will probably be cut down.

"If the producer of crude oil will appreciably increase the percentage recovery of oil from the sands, if the refiner will double the production of gasoline made by the cracking process, and if the automobile manufacturer will market cars that will travel twice the distance of the present cars on the same amount of motor fuel, we will not need to discover new fields as often as in the past or to maintain the same rate of increase in the production of crude oil in order to meet the gasoline demand of the future." D. C. L.

Chemistry in the Rosenwald Museum. EDITORIAL. *Chem. Bull.*, **13**, 271 (Nov., 1926).—The Rosenwald Museum is being established in Chicago. Mr. Rosenwald, according to press notices, received the idea of an industrial museum from the newly opened Deutsches Industrial Museum in Munich. While the Munich Museum will not be copied in the Chicago plans, it offers many suggestions. It is one of the finest and the most distinctively technical museums in the world. In it chemistry is stressed and occupies an entire section of the building. There are reproductions of typical laboratories of alchemical times, of the eighteenth, nineteenth (Liebig's laboratory at Giessen), and twentieth centuries and also specimens from the laboratories of Emil Fischer and other masters. Diagrams, models, samples, and miniature factories illustrate chemical transformations and important processes.

The Munich exhibit is the result of many years of work by willing men of such caliber as von Baeyer, Willstätter, and Diusberg. Great firms place exhibits in the building at large expense. The success of the Rosenwald Museum depends upon the coöperation of the chemists and industries of Chicago and the Middle West. Our obligation is to insist that chemistry shall have its place in the museum and to persuade the chemical industries that the project is worthy of their support. E. L. M.

Progressive Trends in Secondary Education. BURTON P. FOWLER. *Sch. and Soc.*, **24**, 596–602 (Nov. 13, 1926).—This article deals with the better adaptation of our educational materials to students. Curricular revision appears to be an outstanding characteristic of present educational development in America. The curriculum makers of the future must attempt to solve the question, "What education is of the most worth and what should one know in this modern world?" That the old, traditional, disciplinary school will eventually give way entirely to the informal, homelike, modern school, the principle of which, Dr. DeCroly says, is learning-by-living, is probable. Marked strides have been made both in the elementary schools and in colleges, but in secondary schools tradition still rules. The junior high-school movement, however, was one of curricular revision. At the beginning of the 20th century a few principals recognized the educational value of athletics, clubs, plays, etc., and observed that when they developed out of related interests in school subjects they were of even greater value. It is almost an established fact that subject-matter must vary with the individual; consequently, the discoveries of educational psychology point out that the modern high school must recognize adjustment as its most fundamental problem. The class-room should be more or less of a laboratory—a place where productive work is done. There should be a decided relation between first-hand information and that acquired from books.

In order to improve our learning in high schools some plan must be devised whereby every student, whether gifted or slow, may learn according to his own ability, and where the instinctive desire to learn may be preserved. Bertrand Russell has said, "The instinctive foundation of the intellectual life is curiosity." A noted educator once remarked that there are two qualities which the American high-school graduate lacks: a sense of responsibility and intellectual curiosity. K. S. H.

The Mastery of the Hormones. L. M. HUSSEY. *Am. Mercury*, **9**, 447–50 (Dec., 1926).—In the days of Brown-Sequard little was known concerning the functions of the glands and even less about the hormones which they secrete. Physicians paid little attention to them and it was not until twenty years ago that J. J. Abel of Johns

Hopkins isolated epinephrin and found that it was this substance, poured into the blood stream, that regulated the pressure of the blood in the normal human body.

Then followed the theory that iodine was a goiter preventive. Due to the fact that the hormone of the thyroid gland, thyroxin, had been found to contain iodine and because the water supply in the Goiter Belt was found to be deficient in this element, goiter was naturally attributed to the lack of a sufficient amount of iodine in the thyroid gland. Consequently it was proposed to urge the refiners of salt to put back into their product some of the iodine lost in the process of refining and one investigator suggested putting an iodine salt in the reservoirs of all cities in the Goiter Belt. This last suggestion, however, met with disapproval. To adminster iodine indiscriminately was considered unwise and dangerous, even a small amount being sufficient to produce the exophthalmic variety of goiter, a type which is caused by an over supply of iodine in the system.

Recent experiments with the pancreatic gland have produced new theories concerning the highly active substance, insulin, which it secretes, a substance which possesses the power when injected into the blood of diabetics of reducing the excessive blood sugar.

Then came the work only a short time ago of Dandy and Reichert of Johns Hopkins, results of which have completely upset the theory which has prevailed and been taught, that the pituitary gland is essential to life and that its removal inevitably results in death. These investigators felt it was the injury to the brain in the removal of the gland and not the loss of the gland itself which resulted in death. This they proved by employing different technic wherein the surrounding brain tissue was not injured and the gland was successfully removed. K. S. H.

The Teaching of Chemistry in the Early American Secondary Schools. S. R. POWERS. *Sch. and Soc.*, **24**, 497–503 (Oct. 23, 1926).—Cubberley, a writer on the history of education, implies that chemistry was not included in the curricula of secondary schools previous to 1850, and according to Ernst von Meyer, as late as the beginning of the 19th century there were practically no laboratories for general instruction in this science. This, however, seems to conflict with statements contained in the educational literature of this earlier period.

As early as 1754 Columbia provided lectures in chemistry for medical students and soon after made it a requirement for the B.A. degree. Scientific societies were established and of the forty-some colleges in existence in 1817, all taught some branch of science, the teaching being done by the physicians and clergy. Evidence shows that in a large number of the schools the lectures on chemistry were supplemented by experimental demonstrations. Laboratory equipment was difficult to obtain and the shortage of qualified teachers made the question of elementary text-books a very important one. A text-book by Amos Eaton (1822) gave directions for making or borrowing from a druggist the necessary apparatus; larger pieces being ordered from England. By 1837 twenty-seven texts were on the market.

In 1824 Stephen Van Rensselaer established and endowed the Rensselaer Polytechnic Institute at Troy, N. Y., and engaged Amos Eaton as senior professor. The object of the school was to train youths for the service of science teaching, and in order to extend his influence, the founder planned to train teachers to serve as outside lecturers. Each county was invited to send one student for gratuitous instruction; in return, the student was expected to engage in the work of giving instruction in the sciences in the common schools in the county from which he was sent. The Rensselaer School was without doubt responsible for the progress which chemistry made during the early part of the 19th century.

The first public high school appeared in Boston in 1821 and by 1837 eleven had sprung up throughout the United States. The second high school, a school for girls founded in Boston in 1826, was the first of its kind to provide for instruction in chemistry, making it a required subject.

Evidence indicates that chemistry has had a place in secondary education since the beginning of the academy movement, a movement started by Benjamin Franklin in 1749, and was given more or less of a prominent place because its promoters believed that a knowledge of this science was almost essential in the trades, industries, and professions. K. S. H.

Education and the Useful Life. WILLIAM BENNETT BIZZELL. *Sch. and Soc.*, **24**, 561–7 (Nov. 6, 1926).—An address delivered at the opening of the 35th academic session of the University of Oklahoma in which Dr. Bizzell quotes the inscription which appears above historic Langdell Hall at Harvard, "Thou shalt teach them ordinances and laws and shalt show them the way in which they must walk and the work that they

must do," and says that it might appropriately be made the motto of every higher institution of learning. He stresses the fact that the University of Oklahoma is supported by taxpayers on the theory that those who accept the advantages it offers will return to the state some form of productive achievement. The idea that the institution and its facilities are free is enormous. "Education is expensive, and the more advanced the instruction the greater the cost." Consequently, to accept its advantages without assuming any responsibility is dishonest. A university is expected to turn out intelligent and reflective men and women, but because many of the students of today enroll for the social advantages, fraternal opportunities, athletics, etc., rather than for the purpose of acquiring an education, the task has become a difficult one. "It is not surprising," Dr. Bizzell states, "that young people enter college with distorted notions and misplaced interest when such a widely read author as H. G. Wells proclaims to the world that our educational institutions are 'baseball and football universities, where every sort of intellectual activity is subordinated to a main business of attracting, boarding, and amusing our adolescence.'" The pursuit of knowledge, Dr. Bizzell goes on to say, is the most natural activity of man and essential to his happiness. Whatever may be a student's aim, the effort of the university is to impart knowledge that may result in wisdom. The university should be known as a place where the students work hard, where laziness is not tolerated, and where any so inclined are relieved of the idea that the object of an education is to avoid work. Bertrand Russell has said, "no one should be admitted to college unless he satisfies the test of ability, and no one should be allowed to remain unless he satisfies the authorities that he is using time to advantage." Dr. Richard C. Cabot says in his book, "What Men Live By," that, "all that is human in us grows up through selection. By the choice of work, of play, of companions, of words, people are made what they are." Despite the wide variety of choices which college life offers, unfortunately many students choose the poorest.

The road to high intellectual attainment and the one which must be traveled in preparation for life's duties and responsibilities is by no means an easy one. Dr. Bizzell, in answering his own question, "What is the real purpose of our colleges and universities?" quotes Robert Herrick. Is the purpose of the college "to attract students, by athletics and fraternity houses, who hope to mount from one social stratum to a little higher one, or is it for those who desire to follow the long, hard road of science and scholarship to keep alight the sacred fires of learning?" A noted French educator says that students are being trained to learn rather than to think.

If the widespread talk among college students concerning "snap" courses has any foundation, there should be a thorough evaluation of all courses the students are permitted to elect. The facts of science are important and no instructor is doing his duty who does not guide his students "according to the great sign posts of truth." Dr. Bizzell defines college spirit as loyalty and states that one's loyalty to an institution should not be neglected because of his loyalty to organizations which the institution fosters. A university is no place for the student who ignores the well-established social-traditions and Dr. Bizzell urges the students to keep the ideal of a useful life before them and to do the things that need to be done, quoting John Ruskin as having said, "The entire object of true education is to make people not merely do the right thing, but enjoy right things." K. S. H.

Shall We Have Chromium-Plated Gold Jewelry? C. H. PROCTOR. *Metal Ind.*, **24,** 419–20 (1926).—Chromium-plated articles because of their bright luster, extreme hardness, bluish white color and non-tarnishing qualities are being used not only in the automobile industry but also in the jewelry trade. The articles plated resemble white gold and as a low karat gold ornament plated with chromium has similar properties to a high karat white gold one there is a danger that dishonest or unscrupulous dealers will sell such articles under false pretenses. To avoid this it is suggested that each article plated be stamped as to its gold and alloy content. A tag issued by the Jeweler's Board of Trade stating that the product is coated with chromium to protect it from tarnishing and to increase its wearing qualities should also be attached. Several formulas for plating articles with chromium are given. G. B. HEISIG

Teacher Tenure. E. M. HAGGERTY. *League Script*, **6,** 5–17 (1926).—A brief history of teacher tenure is outlined and the laws which various states have on the subject are summarized. The principle of teacher tenure is discussed from the side of the teacher as well as that of the community. There is no doubt as to the advisability of giving a competent teacher a permanent position, as this leaves his mind and energy free to engage in his work. The school system is also stabilized and its efficiency is increased. The difficulty of framing a law which will protect the competent teacher and at the same time enable the community to rid itself of an inefficient educator with the least disturbance is pointed out.

The best legistation is that in effect in Massachusetts. A teacher may be dismissed for "unbecoming conduct" only after charges have been made and a trial before the school committee has been held. A two-thirds vote of the committee is necessary for action and no appeal can be made. This eliminates undue publicity and prevents discord between the administration and the public which may result from a court trial. As it is difficult for an outsider to judge a teacher's ability, the teachers themselves must coöperate to expel from their ranks those who are not efficient. Only in this way will a competent teaching organization which would justify a tenure law be developed.

G. B. HEISIG

Can Education Increase Intelligence? A DEBATE. *Forum*, **76**, 498–509 (Oct., 1926).—Negative taken by Prof. William McDougall of Harvard. Attendance at a good school disciplines the character, imparts respect for persons, institutions, and ideals, and teaches the art of getting on with our fellows. Further it is the best way yet devised for securing to children *en masse* a vast amount of knowledge and skill. Yet we all know men who have worked diligently through school and college and yet who seem to us stupid, learned perhaps, but nevertheless essentially unintelligent. And we all know men who have had little or no schooling and yet seem to us highly intelligent, shrewd, of sound judgment, or quick to sieze a point—men we would rank higher in the scale of intelligence than some learned fools.

Education seems to be essentially a differentiating, rather than a leveling process.

The ardent educationist blames the home and unfortunate parents for the relative failures of the educational process. While the truth about the pre-school years seems to be that while they are of greatest importance in development of character they are only of very slight importance in the development of intelligence.

It is pretty well agreed that intelligence implies plasticity and adaptability, the power of dealing effectively with novel situations—beyond this there is little or no agreement. If we use intelligence in a large and loose sense to cover all that contributes to render a man well fitted for life, then education does increase intelligence, but it should be limited to that factor which is displayed most clearly in the acquisition of knowledge and skill and not identified with the products of its operation. There is little reason to believe formal education can develop this.

Affirmative is taken by Prof. I. A. Richards, of Magdalene College, Cambridge. Objects to McDougall's definition on the grounds that it makes us victims of verbal abstractions as its origin is in a linguistic convenience. However, his chief quarrel is with McDougall's conclusions. It does not follow because a child who got a good start usually goes on increasing his lead that education has little to do with the matter.

The distinction between character and intelligence, though popular and useful for some purposes, is a very doubtful affair. Some of the main factors governing intelligent behavior are to be found in character.

The "power of dealing effectively with novel situations" is really the power of generalizing and an educator who can make his pupils see that all their work is an exercise in thinking can increase their power to generalize.

We should take the hopeful view and although we know our educational methods to be defective we should be critical of any argument which tends to make their improvements seem a minor matter.

"If we get rid of the notion that 'education' means a single influence like a trade wind blowing in a single direction and if we are on our guard against 'intelligence' as the name for an abstract 'faculty' we shall see abundant reason to think that the difference between able and stupid persons is to be explained by the early accident of their lives rather than by an inborn unchangeable endowment."

J. W. HOWARD

Atoms of Energy. PAUL R. HEYL. *Sci. Monthly*, **23**, 298–402 (Nov., 1926).—Although the atomic theory of matter was established in the early part of the nineteenth century, the belief that matter was continuous had its adherents all through that century, the last of whom did not die until 1916. In 1900 Planck put forward the idea that energy must also be regarded as made up of individual atoms or quanta. Something of this nature was earlier proposed by J. J. Thomson because of the effect of X-rays on a gas. Planck, however, was led to his hypothesis by difficulties encountered in the theory of radiation. According to the idea proposed by Planck, when a molecule gains or loses energy it must do so by sudden jumps, one or more quanta at a time, and not by continuous change. H. cites a number of applications of this theory, among which are Dulong and Petit's law and Bohr's theory of atomic structure. Though attempts to give a mental picture of the quantum theory have been unsatisfactory, H. suggests that we must do our best at an understanding of it since he believes it will supersede the classical wave theory.

G. W. S.

The Stuff That Things Are Made of. CHARLES E. MUNROE. *Sci. Monthly*, **23**, 450–3 (Nov., 1926).—A popular radio talk on the desire of mankind to find out the composition of substances and how this desire caused the investigations that have led to the development of the science of chemistry. A number of illustrations are given.
G. W. S.

Ancient and Modern Alchemy. FRITZ PANETH. *Science*, **64**, 409–17 (Oct. 29, 1926).—The trend of modern chemistry is toward rather than away from the theories of alchemy. Although much of its "creed" was without doubt in error, alchemy remained in disrepute only a comparatively short time. It has recently emerged.

The reasons for the persistence of the "transmutation" theory, in spite of repeated failure of "transmutation" experiments were: 1. The apparent change of iron utensils into copper by immersing in the waters of certain springs (copper-bearing). 2. The fact that men readily believe what they wish to believe. 3. The four elements of Aristotle which were merely properties indicated that changing properties meant changing matter (transmutation).

Boyle suspected the possibility of certain composite structures behaving as elementary. He also suspected the existence of "some agent. . . . .so subtile and so powerful. . . . . as to be able to resolve them into those more simple ones whereof they consist." These words are prophetic of the first successful "transmutation" experiments, those of Rutherford in which hydrogen was obtained by bombarding aluminum with alpha particles. Radium seems the nearest approach to the "Philosopher's Stone" and the modern alchemy as typified by the work of Rutherford is a matter of theoretical knowledge, not of practical utility.
G. H. W.

Calculation of the Ages of Radioactive Minerals. A. HOLMES AND R. W. LAWSON. *Nature*, **118**, 478 (Oct. 2, 1926).—Granting certain conditions of suitability the age of a primary radioactive mineral is given to a first approximation in millions of years by the formula $Pb.C/(U + k.Th)$ where k is the amount of uranium which is equivalent in lead-producing capacity to 1 g. of thorium and $1/C$ is the amount of lead produced by 1 g. of uranium in a million years. The constants adopted are $C = 7400$ and $k = 0.38$. Reasons for adopting these values are given.
H. K. M.

Antagonistic Action of Electrolytes and Permeability of Membranes. K. C. SEN. *Nature*, **118**, 48 (Oct. 2, 1926).—The equilibrium in biological systems, the inversion of emulsions and the coagulation of colloids in the presence of mixtures of salts can all be explained by the view that salts of calcium promote and alkalies and salts of sodium inhibit the transformation of a system consisting of a non-aqueous phase dispersed in water into the reverse type of system consisting of water more or less perfectly dispersed in a non-aqueous phase. All antagonistic actions occur between a peptizing agent and a coagulation agent.

The nature of the electric charge on the surface of the dispersed particles in the case of physiological systems must be of fundamental importance in showing a variable permeability under different conditions.
H. K. M.

The Scope of Organic Chemistry. J. F. THORPE. *Nature*, **118**, 483–6 (Oct. 2, 1926).—From the presidential address to Section B of the British Association delivered at Oxford on August 5th.
H. K. M.

The Alloys of Aluminum and Silicon. F. C. T. *Nature*, **118**, 498–9 (Oct. 2, 1926).—A review of three papers presented to the Institute of Metals at Liege. The modifying reagents are functioning as colloid protectors and the importance of the colloid state in alloys at the moment of solidification and of under-cooling is shown to be far greater than has hitherto been generally appreciated.
H. K. M.

Francis Bacon and Scientific Method. C. D. BROAD. *Nature*, **118**, 487–8; 523–4 (Oct. 2, 1926).—A short sketch of interest to all who strive to teach the scientific method.
H. K. M.

A Communistic Program in Education. E. FROST. *Educ. Rev.*, **72**, 148–51 (Oct. 1, 1926).—A comment on an able and diverting paper entitled "What the Colleges Can Do for the Public Schools," by F. D. Boynton. "To give to every individual his opportunity through education, to develop whatever capacities he may possess" may be a major premise distant of realization, but one for which we can share in Boynton's enthusiasm. To imply, however, that a college education is an "inalienable right—regardless of the quality and quantity of one's endowment" is an absurd minor premise. Success, however measured, does not need to wait upon a college education. A college education is only one kind of education. Let us not impair the effectiveness of it by offering it to the unscholarly. Let him who is not a potential scholar turn where his talents and abilities and interests lead him, the vocational school, the bank, the farm, industry (either the mechanic's bench or the executive's office), and business generally.
H. K. M.

Analysis of Line Spectra. A. FOWLER. *Nature*, **118,** 593, 596 (Oct. 23, 1926).—From the presidential address delivered to Section A of the British Association at Oxford on August 9th. H. K. M.

The Occurrence of Helium and Neon in Vacuum Tubes. E. C. C. BALY AND R. W. RIDING. *Nature*, **118,** 625–6 (Oct. 30, 1926).—Helium and neon have been obtained by passing the discharge between a concave aluminum mirror as cathode and a magnesium anode through a mixture of oxygen and nitrogen under reduced pressure. No trace of the rare gases was formed if the discharge were passed in the opposite direction. The character of the discharge was found to be of great importance as the production of the rare gases depended on the length of the auxiliary spark-gap, the capacity of the condenser and the pressure of the gases. This lends confirmation to the observations of Collie, Patterson, and Masson. H. K. M.

Unit Costs of Instruction in the High School. V. A. GARVER. *High Sch. Teacher*, **2,** 312–4 (Oct., 1926).—This article presents a study of expenditures for teaching cost for various subjects in high schools. The study extends over a period of three years, in the last of which high schools from six different counties in Ohio were surveyed. The cost is measured in terms of dollars per T. S. H. (Thousand Student Hours).

The schools are grouped into: A, those having below 50 students; B, having between 51 and 100 students; C, with 100 to 200 students; and D, with more than 200.

Median costs for D schools are lowest though not greatly different from C. The highest median cost is found in A schools. The widest distribution of cost is also found there. In general, the author finds the teaching cost per subject is a function of the number of pupils in the class taught.

Science teachers will be interested in the following tabulations taken from the author's Tables IX and XI, respectively.

TEACHING COST

Subject	Number of cases	Lowest cost	Median cost	Highest cost
English	78	$36	$ 84	$233
Latin	75	32	152	625
Plane Geometry	59	38	126	466
Physics	41	39	158	500
Biology	52	37	72	370
General Science	43	32	70	550
H. S. Geography	38	48	100	576
Hygiene	8	37	92	360
Chemistry	13	51	82	400
Domestic Science	38	44	103	240
Civics	55	33	72	625
Agriculture	37	50	141	451

SIZE OF CLASSES

Subject	Number of cases	Smallest class	Median size class	Largest class
English	78	3	18	32
Latin	75	1	9	31
Plane Geometry	59	1	12	37
Physics	41	1	9	36
Biology	52	3	19	35
General Science	43	2	19	44
H. S. Geography	38	4	13	26
Hygiene	8	5	12	31
Chemistry	13	5	18	27
Domestic Science	38	5	12	24
Civics	55	1	19	53
Agriculture	37	3	11	33

Suggestions made are: to increase size of classes and so decrease teaching cost. To do this the author advises: consolidation of smaller schools, equalization of teaching loads, establishment of a minimum size for a class and discontinuance of classes that are smaller than that minimum, and the alternation of courses thus permitting the combination of classes in the smaller schools. B. C. H.

Education, the Open Door to Opportunity. F. D. BOYNTON. *Educ. Rev.*, **72,** 151 (Oct. 1, 1926).—A reply to comments on an earlier article entitled "What the Colleges Can Do for the Schools." Most of the commentators freely admit and frankly deplore the confusion, the uncertainty, the irrationality, and inflexibility in the application of entrance requirements. They agree that there is far too much poor teaching, far too little supervision of the immature student with its inevitable result of an abnormally and unnecessarily high percentage of academic mortality among freshmen and far too little effort made for organization and correlation of college courses and schedules. The root of the evil is the problem of maintaining the open door to opportunity through education for every individual capable of seizing it and profiting by it. It is here that the misunderstanding develops and that Boynton makes himself plainer in the present paper. H. K. M.

Morals and Chemistry. K. M. PERSING. *Educ. Rev.*, **72,** 164–8 (Nov. 1, 1926).—The students are instructed to check the grading on their written work which is returned to them in some cases with grades too high, in others too low. Care is exercised not to have too many errors in grading so as not to arouse suspicion. At the end of the year a questionnaire is given concerning the honesty of receiving too much change in a business deal or too high grade in an examination book, etc. The results are tabulated and show that 97 per cent will report a low grade which agrees with the questionnaire. Only 9.5 per cent reported over grades while 87 per cent said they would. A study in bridging the gap between mere possession of moral ideals and their proper functioning. H. K. M.

Class Size in Universities. E. HUDELSON. *Educ. Rev.*, **72,** 231–4 (Nov. 1, 1926).—Neither the general research committee at Minnesota nor the sub-committee on class size is ready to propose a general increase in the size of university classes. If further investigations confirm the Michigan and Minnesota evidence that differences in efficiency between small and large classes are so slight under present methods of instruction and class-room management the question arises, "Can classroom technic be refined or modified so as to produce results distinctly favorable to larger university classes?" H. K. M.

What Colleges Are For. H. A. PERKINS. *Educ. Rev.*, **72,** 217–22 (Nov. 1, 1926).—A broad visioned outlook written by a scientist that is worth a few minutes of the time of anyone interested in education. H. K. M.

Wonderlands of Tomorrow. HENRY D. HUBBARD. *Tycos*, **16,** 136–8 (Oct., 1926).—"Science cancels the word 'impossible,'" says the author and then starts a marvelous story which in a way removes "Jules Verne. . . . . from the fiction to the science shelf of our library." Starting with automatic machines which he thinks will be enlarged to automatic plants he sees the human mind of the future freed from routine and so endowed with leisure to think and to enjoy.

In the realm of chemistry, according to the author, "the creation of new groups of atoms means a new era in human progress based upon the chemist's power to produce at will forms of matter and energy having any desired properties." Among the creations thus credited to the chemist he enumerates, "theine which greatly stimulates without intoxication; adrenalin which duplicates nature's control of heart and lungs; the complex iodine group which controls body growth; atom arrangements which reproduce the sweetness of sugar, the perfume of flowers, the color of their petals, the power to treat disease, to stir the heart to action, to relieve pain, or put the body into sound sleep." And yet chemistry's part is said to have just begun.

Crop production control is discussed. "Indoor farming" is suggested with proper soil, pest-free air humidified to the proper degree with even the radiation factor made the optimum for the given crop.

Already "word comes from France and England that in the test-tube, at least, the chemist has produced starch and sugar directly from the air by the synthesis of moisture and carbon dioxide—through the aid of ultra-violet light of suitable wavelength. Some day continuous starches and sugars may pour forth from factories to feed the world."

The article then proceeds to take up the subject of artificial climates, "cold rooms for food, and hot houses for plants;" and who will deny that soon "we may bring the best climates of the world into our living rooms?"

We have yet to approach the aviation speed of an 815-mile per hour insect recently described by one of our entomologists. The future may find these high-speed aviation machines directed by radio control, or maybe communication may be by radio vision, that is, "radio post will deliver the world's correspondence instantly."

Interplanetary communication receives attention, musical and other tones as yet

unattained are prognosticated, and even Ponce de Leon's fabled fountain which would give perpetual youth has a counterpart in laboratory experiments in the Rockefeller Medical Institute. "To prolong indefinitely the life of the heart of a chick is a first step in doing the same for the entire chick, then for higher organisms. . . . . perhaps eventually for man. . . . . To extend life indefinitely is now a fascinating dream of present day science." B. C. H.

The Human Side of Chemistry. E. E. SLOSSON. *The Chemist* (Denver), **4**, 5–6 (1926).—"A hundred years ago chemistry was a toy," a plaything; today it is a living throbbing workman, mature and self-supporting although its work is not all visible to the eye of the layman.

For one thing the chemist is too modest—he takes not even as much credit as the oyster when he makes a pearl, or as a silk worm when he spins silk. He has various opportunities to make his work better known. In the matter of word coinage he is in the forefront. "The expansion of chemistry has demanded the fabrication of 250,000 new names with provision for an indefinite increase in the future. . . . . He has doubled the dictionary."

If his is the creative science, his opportunities are the greatest. The basic reaction on which our vital and mechanical power depends is the oxidation of carbon and hydrogen. The physicist and the biologist both concede that chemistry is the science which controls both our food and fuel supply and so the future of civilization. If the period of extension of civilization is at its close the intensification of civilization must be the next step of progress. In this the chemist will certainly be called upon to take a major rôle.

However, we cannot, as formerly, separate the sciences and their functions. The new era is a period of mergers. Scientists are discovering what artists have long known—that there are no clear-cut lines in nature; acetic acid may be made by a vinegar plant or a hydroelectric plant; rickets in children may be cured by sunlight or by cod-liver oil; physics and chemistry share honors in this service.

Chemistry has reduced extremes of social privileges. "Luxuries, formerly the monopoly of the privileged classes, become, through applied science, the common property of the masses." The poor have their sickness cured by medicines not obtainable by a Caesar or a Napoleon; they may for a modest fee speed over earth's surface at a rate surpassing seven league boots. Books, pictures and music all stand in grateful recognition before their patron the chemist. "Whether it be our material wants or our aspirations for art and literature, the chemist acts as the agent of applied democracy."

The chemist in his production of writing paper wielded a far larger influence than Gutenburg with his invention of movable type. Type could be done away with and a photographic process substituted, but paper—never. Man is eye-minded—so we appreciate the value of the pictures and of the whole photographic process, especially the art of reproducing motion. Just as the scientist of today thinks in terms of motion, so the artist tomorrow will revolutionize his art, and consider motion its prime essential.

To place chemistry in its rightful place as creative workman, understood by the public whom it gladly serves, the author would change several habits of the chemists. He would make him more eager to translate his science into ordinary English presented in an attractive style. He can find plenty of people who will write for his *Science Service* about birds, bees, stars or star-fish, but not about chemistry. He would have the writers of chemistry text-books include the human interest stories and the struggles which accompanied chemical discoveries and development.

He would, like Agassiz, require of his embryonic chemistry authors that they write: "first, a monograph; second, a scientific lecture; third, a popular lecture; and fourth, a simple child's tale." He asks how many Ph.D.'s could pass the third and fourth of these intelligence tests. MRS. B. C. H.

The Necessity for Research in Education. A. N. JORGENSEN. *Sch. Bd. J.*, **73**, 41–2 (Aug., 1926).—The author states that research in education is essential if the problems which are increasing in number and becoming more complex are to be solved. These problems, those of our social scheme and many others, are in need of the guidance which research affords. During the World War, the necessity for research was recognized and most of the governments involved established laboratories for the purpose of making their resources go the farthest. The various departments of our own government, with their divisions of research and experiment stations, illustrate the government's attitude toward research.

Research seems to have become more or less of an indispensable part of our social life. A recent survey indicates over 500 private industrial establishments in which

scientific work of a high grade is being carried on. Much scientific work is being done by societies, state universities, and organizations like the Carnegie and Rockefeller Institutes. In the last decade, research bureaus have been established in more than 50 cities, and are becoming highly important factors in our state universities. Local, state, and national teachers' associations are developing research departments and many periodicals dealing with results of research on education are being published. Superintendents and boards of education have seen its value and are attempting to develop it with the result that statistics are properly treated and interpreted rather than considered as mere tabulations.

A second series of investigations would include the study of building up a sound organization, a strong staff, a satisfactory building program, and a plan of finance. A classification of the staff, salary schedules, retirement and pension programs, etc., must be studied if the school policy is to be developed. Supervision and instruction are ineffective without the information which results from an exhaustive study of the problems involved. Pupils should be properly classified, adjusted to the curricula and kept moving as fast as their abilities will permit. Knowledge is necessary as to their intelligence, physical condition, social heredity, present environment, and the lines along which the best that is in them may be drawn out and developed. The worth of the teaching method, the meaning of marks, and the placing of each child under the instruction best suited to him, must be the result of thorough study. An additional group of problems would center about the types of curricula, schools, rooms, and courses. The author stresses the fact that investigation and experiment are the most intelligent ways of carrying on the administrative processes in a modern school system. That the modern teacher, supervisor, or administrator must be guided by the authority of facts is acknowledged. K. S. H.

A Method of Increasing Interest and Providing for Individual Differences in the High-School Science Laboratory. HARLAND M. BRIGHT AND G. L. BUSH. *Sch. Rev.*, 34, 782–6 (Dec., 1926).—A brief description with typical outlines as illustrations of the scheme whereby students choose from a list of several experiments, the experiment or experiments to be performed on a given topic—thus allowing for difference in ability, previous experience, etc., and maintaining interest. B. H. B.

Use of Tetraethyl Lead. ANON. *Tech. Rev.*, **28**, 252 (1926).—"Findings of the Surgeon General's Committee, regarding the possible physiological dangers of the use of lead tetraethyl as a knock suppressor in motor fuels have revived the controversy regarding the use of this valuable organic compound for the increased efficiency and economy of automobile engines."

The finding of this committee was to the effect that no decisive indication of lead poisoning among chauffeurs or garage workers had been observed where leaded gasoline had been used for three years; hence there was no menace in selling leaded gasoline if four precautions were taken:

(1) The mixture of lead tetraethyl with gasoline should be confined to as few central plants as possible.

(2) The leaded gasoline should be colored to distinguish it from ordinary gasoline and to warn people from using it for cleaning clothes, washing hands, etc.

(3) Signs should be placed at filling stations, warning customers that leaded gasoline is for use only in motor cars.

(4) Study of the effects of leaded gasoline should be continued on the chance that chronic degenerative disorders of unobvious character might slowly be setting in.

"Some time must still elapse before the use of lead tetraethyl will become a widespread benefit to the automotive industry. No great good can come of its use until its manufacture and distribution shall have progressed to such an extent that its use has become universal. This universality will permit of the redesign of automotive engines to work at high compression. It is essentially the higher compression engine to which the industry must look in its effort at fuel economy.

"A future saving of twenty-five per cent in the nation's consumption of gasoline would be possible as soon as lead-treated gasoline is the one standard fuel. All this may be brought about by the addition of one part in 1500 of $Pb(C_2H_5)_4$." S. W. H.

Local Activities and Opportunities

University of Chicago. Mr. George Herbert Jones has contributed to the University the sum of $415,000, with which the first unit of the proposed chemistry laboratory will be built and equipped. This unit will enable the department of chemistry to provide the greatly needed modern facilities for its research students; it will also relieve, to a very great extent, the hardships caused by lack of space to undergraduates and graduates alike and will permit of some expansion in the faculty and in the lines of research undertaken. Mr. Jones is a Director of the Inland Steel Company. He started with the company in its earliest days, before it had become a great corporation. Mrs. Jones is the daughter of Elias Colbert, formerly professor of astronomy in the old University of Chicago.

Professor Gilbert N. Lewis will spend the entire quarter at the University of Chicago, Summer, 1927, as the first holder of the Ernest A. Hammill Visiting Professorship. Dr. Lewis will present a lecture course on "Valence and the Structure of the Atom" and will also conduct a Seminar in the field of thermodynamics.

Minnesota Section, A. C. S. The following men were elected officers of the Minnesota Section for the coming year: Chairman, J. J. Willaman; Vice Chairman, A. A. Schaal; Secretary, G. H. Montillon; Treasurer, W. W. Swanson; Councilors, M. C. Sneed and C. H. Bailey; Contributing Editor to the JOURNAL OF CHEMICAL EDUCATION, G. B. Heisig; Senators of Chemical Education, P. M. Glasoe, J. A. Smith, and V. H. Roehrich.

Sacramento Section, A. C. S. The newly elected officers for the Sacramento Section for the year of 1927 are as follows: Chairman, J. H. Jonte; Vice Chairman, H. C. Davis; Councilor, W. J. Lentz; Senator of Chemical Education, J. H. Norton; Secretary-Treasurer, R. P. Tucker.

University of Florida. The cornerstone of the new Chemistry-Pharmacy building was laid with appropriate ceremonies December 15th, in the presence of notable alumni and visitors from all parts of the state. The program was as follows:

Procession, led by University band, from old Science Hall.

Dedicatory prayer, Dr. T. V. McCall.

Address, Dr. J. M. Farr, vice president, U. of Florida.

Greeting from the chemists of the State, Mr. L. M. Drake, Drake Laboratories, Daytona, Fla.

Greeting from the pharmacists of the State, Mr. J. K. Atwood, President, Florida State Pharmaceutical Ass'n.

Address, Mr. J. J. Gerig, ex-president, Florida State Pharmaceutical Ass'n.

Laying of the cornerstone, Gamma Sigma Epsilon Chemical Fraternity.

The exercises were followed by a formal dress parade by the University Battalion, which was reviewed by the guests of the university.

Many congratulatory telegrams and letters have been received.

Maryland Section, A. C. S. Dr. W. A. Taylor, President and Chemical Director of the LaMotte Chemical Products Company, addressed the Maryland Section of the American Chemical Society on December 17th. The subject of his talk was "Hydrogen Ions in Industry."

Lexington Section, A. C. S. The Lexington Section of the American Chemical Society held its 116th regular meeting at the University of Kentucky on January 12th. At that time an address was given by Mr. T. M. Hahn on "The Modern Situation of X-Ray Analysis."

Recent Books

What Price Progress? HUGH FARRELL. G. P. Putnam's Sons, New York, 1926. viii + 323 pp., 13.25 × 19.5 cm. $1.00.

"What Price Progress?" is a financial editor's brief for research.

The author analyzes several basic industries with reference to their financial progress during the past years. As a result he shows how fundamental research yields substantial returns to those concerns, the directors of which have been sufficiently foresighted to inaugurate a basic program of research and how the lack of new knowledge or its application brings serious financial difficulties to concerns whose officers see no need for a real research staff.

The book is reasonably free from inaccurate technical statements. It provides fascinating reading for the layman, teacher, and student. Its style is simple and direct. The dollar value of science is clearly pictured.

C. E. K. MEES

Teaching First-Year Chemistry. J. O. FRANK, A.M., Professor of Chemistry in the Wisconsin State Teachers' College. Third edition, revised and enlarged. J. O. Frank, Oshkosh, Wisconsin, 1926. 121 pp. 15.2 × 22.2 cm. $1.50 postpaid.

The author states the purpose of the book to be that of supplying material which will be of immediate aid to those who are teaching first-year chemistry and to offer interpretation of available evidence pertaining to unsettled questions of chemical instruction; and, further, to include suggestions on the teaching of qualitative analysis as a high-school subject.

A dearth of text-books suitable for college students preparing to teach high-school chemistry is evidenced the country over by instructors who have charge of such courses, and it is with considerable disappointment, therefore, that one reads in the introduction of this book that the author claims for it only "a collection of notes and suggestions on the betterment of the teaching of chemistry," and that "its main contribution is intended to be the *literature which it recommends* to the teacher."

The subject-matter of the book is largely in outline form with copious notes and some discussion. Some parts apparently are complete; others show need of revision in order to condense the material and to rid it of repetitions and conflicting statements.

A challenge to science is extended through the pages of the first chapter in which attention is called to present-day social conditions and to the exigencies of our wavering civilization. This is followed by a brief history of chemistry in the early high schools, one-half the space being given to the criticism of college domination of the high schools. The content of the chapters dealing with methods of teaching chemistry is very similar to that found in most texts on the teaching of science, and includes pages devoted to measurements of results by teaching tests and intelligence tests, with bibliography. Many problems of the high-school chemistry teacher are listed. Some are discussed in detail; some that seem more involved are discussed not at all and leave the beginning teacher without further aid than the simple knowledge that such problems may be met in his experience.

A course for teachers of high-school chemistry given by the author in the Wisconsin State Teachers' College is

described, several pages being devoted to the daily routine of its class-room and laboratory management.

Qualitative analysis is the theme of the final chapter in which some advice is given as to the installation of such a course, the preparation of reagents, the use of the author's manual, the dispensing of unknowns, and an apparatus list. The reviewer is skeptical of the wisdom of establishing such a course in the first year of high-school chemistry.

References to literature include two-hundred and fifty citations which refer for the most part to articles in recent journals. A list of reference books that may be purchased for approximately one hundred dollars might well be in the hands of every high-school librarian.

The book is a worthwhile addition to the literature on the training of chemistry teachers and deserves a place on the reference shelves of instructors of such courses.

R. M. PARR

Modern Science and People's Health. Edited by Benjamin C. Gruenberg. W. W. Norton & Co., Inc., New York, 1926. vi + 250 pp. 14 × 21.5 cm. $2.50.

In an effort to make the public, in general, appreciate the value of science to the health of humanity, Dr. Gruenberg has collected a chapter each from half a dozen authorities in which each one shows how the development of his speciality has reacted to the good of mankind.

Professor Charles R. Stockard of Cornell University Medical College demonstrates the importance of heredity and environment in the development of the individual. Professor Hugh S. Taylor of Princeton explains how important body substances, like insulin, have been made in the laboratory. Professor Walter H. Eddy of Columbia shows how the deficiency diseases can be corrected by the right proportions and kind of food. Dr. William A. White of St. Elizabeth's Hospital in Washington tells of the effects of our complex and trying conditions of modern life on the delicately adjusted nervous mechanism of the human body. Dr. C. E. A. Winslow of Yale gives a comprehensive resumé of what preventive medicine has accomplished. Dr. Haven Emerson, a former public-health official, sums up the experimental work outlined above and shows how the knowledge so acquired works out in application to human problems.

It would be hard to beat these names in any book on the subject and Dr. Gruenberg's long experience in teaching and public health work has shown him what most needs to be known in this field. His introductory essay on "Science in a Democracy" shows the danger and damage done by credulity and illustrates the idea by numerous cases of popular fallacies such as the recent craze for Abrams' "electronic treatment."

E. E. SLOSSON

Casein, Its Preparation, Chemistry and Technical Utilization. E. L. TAGUE, Ph.D., Associate Professor of Chemistry, Kansas State Agricultural College. D. Van Nostrand Co., New York City, 1926. v + 218 pp. 13 × 20 cm. $3.00 net.

In the preface the author states: "It is the purpose of this book to explain the chemistry and industrial uses of casein in the light of present day practice," and the chapters are as follows:

1. General Considerations and Preparation of Pure Casein.
2. Chemistry of Casein.
3. Compounds of Casein with Alkalies and Alkaline Earths.
4. Compounds of Casein with Heavy Metals, etc.
5. Decomposition Products of Casein.
6. Paracasein.
7. Technical Preparation of Casein.
8. Technical Uses of Casein. Patents.

Bibliography. Index.

The author has accumulated a large

mass of data and arranged it as indicated; but there is much in R. Scherer's book on casein and elsewhere which does not appear here. The 267 references are collected alphabetically at the end of the book and thus constitute an author's index. But Dr. Tague's name does not appear at all and the book seems to reflect this fact. One feels that it contains too much *ipse dixit* rather than that type of critical discussion which personal contact with the problems should elicit. Thus, what is the value of "the best empirical formula to date, $C_{172}H_{274}N_{48}SPO_{58}$" (Hammersten), when J. B. Leathes points out that in a polypeptid chain of 50 links containing only 19 different kinds of amino acids there are 10^{48} different arrangements possible? What this means may be dimly gauged from the fact that the distance across the Milky Way (an appropriate comparison in the case of casein) *expressed in Ångstrom units* (of which there are 10,000,000 to the mm.), is only 10^{32}.

"In the preface, it is stated: "A large amount of intensive research work must be done before the chemistry of casein will approach anything like completeness. Especially is this true of its compounds with other substances.

"In as much as casein is a colloid, its behavior can be explained best by the principles of colloid chemistry which practice the author has followed throughout this book."

To the reviewer it appears as if many indefinite adsorption complexes (or, to say the least, indefinite compounds of some kind) are given a local habitation and a name, *e. g.*, p. 62, alpha casein, beta casein, iso-casein, caseid, acid and alkali albuminates, and (p. 46, *et seq.*) a variety of halogen compounds. In many instances, these are hang-overs from fossil literature but in any event the old German maxim "*Papier ist geduldig*" must always be borne in mind. To speak of the chloride of an indefinite compound or substance is somewhat like speaking of the chloride of mince pie.

The author gives (pp. 173–205) abstracts of some 165 American and foreign patents which he considers most important and devotes pp. 140–172 to practical uses of casein, and pp. 97–140 to the technical preparation of casein. Since only enough HCl is used technically to bring the p_H to 4.6–4.8, it is hard to see why C.P. HCl is recommended or why the precipitating vats should be made of heavily tinned sheet iron.

In the next edition, it would be well to epitomize standard methods suggested (*e. g.*, A. O. A. C. methods on pp. 136–7), for many who use the book may not have these at hand. The magnitude of the industry may be seen from the statement that in 1922, about 7,000,000 lbs. of casein were used in the plywood industry in the U. S. A. and enormous amounts are imported from Argentine and France. There are big opportunities for the development of the industry here.

The author is to be thanked for tabulating at the outset the existing mess in nomenclature:

American	English	Old French
Casein	$\rightleftharpoons$ Caseinogen	$\rightleftharpoons$ Caseanic Acid
Paracasein	$\rightleftharpoons$ Casein	$\rightleftharpoons$ Caseogen

There is much in the book that will prove of interest, yet much to be desired, and the reviewer hopes that the next index will contain "rennin" and "rennet" as well as "smierkase."

JEROME ALEXANDER

The New Heat Theorem. W. NERNST, translated by Guy Barr from the 2nd German edition. E. P. Dutton and Co., New York, 1926. xvi + 281 pp. 13.5 × 21.5 cm. $4.00.

First published in 1918, revised by author in 1924 by the addition of notes in a supplement, this work has now been translated into English. It suffers from the long period of time that has elapsed between first publication and translation, for the addenda are insufficient to put the serious student of the subject into full contact with the present position

of the famous Heat Theorem of Nernst. The contributions from laboratories other than the Physico-Chemical Institute in Berlin have served to emphasize important aspects and limitations of the theorem which are not treated in this volume. The alternative method of approach to the theorem via atomic and molecular entropies is not given in this volume, a lack which diminishes its value as a general text of the subject.

The volume, however, possesses an inestimable value as a record of a wonderful development in the application of thermodynamics to chemical problems. It is an elegant statement of the classic researches carried out in Berlin in the years of 1906 to 1918 which opened a new avenue into the domain of chemical affinity. It generalized the problem of heat capacity of solid bodies and offered new approaches to the problems of gaseous equilibria. No one can read the volume without feeling inspiration and enthusiasm. It should be in every library and should be familiar to every graduate student.

HUGH S. TAYLOR

Organic Chemistry. WILLIAM ALBERT NOYES, Ph.D., Director of the Chemical Laboratory of the University of Illinois. Henry Holt and Company, New York, 1926. xix + 677 pp. 13.5 × 21.5 cm. $3.50.

Judging from the attitude of many publishers and from the comments made by teachers there seems to be a feeling that most of our text-books on organic chemistry are not satisfactory. Professor Noyes thinks that the trouble is that too much emphasis is placed upon concrete detailed information, thereby obscuring the more important principles. He has, therefore, rewritten his earlier edition with this in mind, reducing considerably the space devoted to experimental detail and data. As a result, the deductive features differentiate the book quite markedly from others in the field. Whether or not, in the case of an experimental science like organic chemistry, it is more advantageous to emphasize this method over the more inductive and experimental approach may still be a matter of opinion. Furthermore, the beginning student must build up a background of facts, if he is to appreciate principles and generalizations, and the omission of detailed information tends to limit the book's value for this purpose.

It still, like most of our texts, retains the more or less conventional emphasis on syntheses and classification according to structural formulas. Thus the author states in the beginning of chapter 4: "The relations of organic compounds to each other and especially those relations which are used in the preparation of compounds and the determination of their structure forms the most important part of the study of organic chemistry."

Among the impressions gained in looking over the pages, is the author's mastery of the subject and his liberal attitude towards various theories and explanations. Another excellent feature is the number of references to the literature dealing with the more fundamental concepts of modern organic chemistry, and also references to recent literature which offer many interesting suggestions for further study and speculation. The reviewer hesitates to give an opinion as to its value as a text for an introductory course, but feels that it would be a valuable addition to the library of the more advanced student.

J. M. NELSON

TO BE REVIEWED LATER

Laboratory Experiments in Dairy Chemistry—Palmer.

Colloid Symposium Monograph. Vol. IV—Edited by H. B. Weiser.

Practical Colloid Chemistry—Ostwald, Kuhn, and Wolski.

A Text-Book of Inorganic Chemistry—Edited by J. Newton Friend.

The Preparation and Analysis of Organic Compounds—Coleman.

Magnetism and Atomic Structure—Stoner.

A FEW MOMENTS WITH THE BUSINESS MANAGER

THE PAST THREE YEARS

The first number of the JOURNAL OF CHEMICAL EDUCATION appeared in January, 1924. It contained twenty pages. During that year ten numbers were issued which contained two hundred and forty-four pages.

The first number of Volume II contained ninety-five pages. The JOURNAL OF CHEMICAL EDUCATION was placed upon a twelve-issue basis because progress in education and science is not limited to ten months of the year and progressive educators wish to keep in active touch with these changes during the summer months. There were one thousand two hundred thirty-three pages of subject-matter exclusive of advertising pages.

Volume III had one hundred twenty-two pages for its first number and contained one thousand four hundred eighty-nine pages exclusive of advertisements. This amount is fifty per cent more than any other magazine devoted to science and its teaching problems.

During the past three years instructors of chemistry, in universities and high schools, have organized local groups in various parts of the country in order that they might exchange ideas, lay out new experiments in teaching technic, etc. These and similar groups are direct evidences of the influence of the JOURNAL OF CHEMICAL EDUCATION. These organizations have given valuable aid to the JOURNAL so we can truthfully say that chemical education is growing because of the marked professional interest and spirit continually being manifested by the chemical organizations coöperating with the JOURNAL OF CHEMICAL EDUCATION.

OUR FOURTH BIRTHDAY

Birthdays are good only when one wonders how much can be done or accomplished before another one comes.

Many of the country's most noted educators and industrialists will have articles in the JOURNAL during 1927.

Many of Europe's celebrated chemists and professors will contribute to our pages during the new year.

Many new magazines will be abstracted so that our readers will have a more complete digest of the world's happenings in the progress of chemical education.

Many unusual illustrations and pictures will be reproduced.

Many more acquaintances—yes, personal ones—with the pace-makers of chemical education will be made for you through the various local organizations sponsored by the Division of Chemical Education.

Many new products, new types of apparatus, new books, new aids, etc., will be brought to your attention through the monthly advertisements of many of America's foremost concerns.

Many new ideas will be suggested by our readers for the continual improvement of our JOURNAL.

As we blow out the fourth candle, our only wish is that we shall continue to merit, in some small way, all of the fine expressions which come daily to us and that you will make it a point to mention the JOURNAL OF CHEMICAL EDUCATION to your friends whenever the occasion permits.